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Nascent Technology

Motivating Force in Western Industry

WHAT do these eleven western states hold of interest to chemical engineers? All are familiar, in a general way at least, with the vast natural resources, the power and fuel developments, and the amazing progress of technology in applying these possessions in the building of a great, almost self-sufficient empire. In the process industries alone there are more than 1,400 plants with an annual output valued at eight hundred millions of dollars. Yet, impressive as these totals are, the real significance is qualitative rather than quantitative. It lies concealed in the spirit of enterprise that in the face of depression has carried chemical engineering to new achievements in fields that had yet to feel its stimulating influence.

MOST STRIKING, from the purely technical viewpoint, are some of those unique developments that find no counterpart elsewhere in the United States or even in the world at large. Iodine recovered commercially from the salt-water wastes of California oil fields; bromine from bitterns; magnesium compounds from sea water; potash and borax from Searles Lake brines; rubber from guayule; agar agar, alginates, and food and medicinal products from kelp and other seaweeds — these are typical of the practical pioneering that is now under way in the West. Despite the hazards involved in launching new enterprises in fields long dominated by established processes, it is certain that a fair proportion of these budding developments will ultimately grow to large and prosperous industries.

THIS SAME SPIRIT of enterprise and daring is also to be seen in the way western industry embarks on its programs of modernization and expansion. Consolidated, at Trail, boldly plunges ten million dollars into a new chemical and fertilizer department to solve its "smoke" problem. Shell, almost over night, builds the largest ammonia and solvents plant on the Coast; Trona spends four and a half millions in doubling its capacity, and during the expansion program maintains its full production. Weyerhaeuser builds its largest paper mill alongside of the already flourishing mills at Longview, Wash. All of this activity in a year of depression is a splendid antidote for the sluggish livers and cold feet of management in certain—let us say—more conservative parts of the country.

TO PROVIDE the chemical engineer with some of the details of this broad picture of western industry, three members of *Chem. & Met.'s* staff spent seven weeks last summer in visiting approximately fifty plants—from San Diego, Calif., to Trail, B. C.—and in talking with several hundred engineers and executives of process industries. Now with the help of more than a score of able contributors, it is our privilege to present in this issue a rather remarkable series of descriptive articles, engineering reviews, and business and industry summaries covering practically the whole field of chemical engineering in the West. This issue, we hope, will be the forerunner of other sectional and regional studies of developments of national interest to the process industries. It is presented with the hope that it will prove as helpful and stimulating to you as a reader as it did to us as your observer. To see western industry in the making is to appreciate the basically important work of the chemical engineer in applying an ever new and ever changing technology.

Chemical Industries of t

Bid for National I

By PAUL D. V. MANNING
Pacific Coast Editor, Chem. & Met., San Francisco, Calif.

OUR eleven western states have, up to the present time, operated as an almost self-sufficient industrial unit. This has been due to the time and cost of transportation, geographical barriers, smaller population, and to that spirit of local and rather practical patriotism always found in more isolated sections. But now, through the influence of developments in which chemical engineering has played an important part, that situation is changing. Western industry has reached a stage where its participants are looking for larger markets. Only the smaller units, mainly of local interest, are content to seek localized business. The Orient, which should form the natural outlet for the products of western industries, has proved disappointing because internal problems of race and government have prevented a progressive development. Markets anticipated five years ago have thus failed to materialize. Meanwhile western industry must sell its goods elsewhere.

Fast and cheap water transportation has made it possible to compete for business, long enjoyed solely by eastern industries, in other sections of the United States, in Mexico, Canada, and in South America. Transportation by rail is entirely practicable in many instances, although the western manufacturer when attempting to sell in the East, faces a situation not entirely unlike that of the eastern producer when selling in the West. However, he does have some inherent advantages over his eastern rival. Climatic conditions in the West help to lower building and production costs. Living costs are lower. Labor is intelligent and content. Power and fuel are cheap. Water transportation has brought raw-material sources much nearer when the needed materials are not already to be found close at hand.

All of these factors have combined to bring about a most favorable development of the chemical engineering group of industries. As this growth has continued, smaller units have merged and, finally, many eastern manufacturers have come west to meet competition by establishing new factories or by buying some of the local ones already in operation. In the latter case there has been, as a rule, very little change in management and policies, and this has made possible a lowering of overhead expenses and the creation of more flexible organizations to meet quickly any change in market situations.

The resources of any locality determine the general type of industries which will develop there. The major resources may be classified into basic groups that form the foundations of the principal or key industries. These in turn must be served by complementary manufacturing enterprises and, as the population increases, so-called "service industries to population" are established.

In surveying the process industries of the eleven western states, they may be classified into five divisions:

1. Mining and production from minerals, including manufacture of products from the sea.
2. Processing of agricultural materials for food and industrial use.
3. Production of petroleum and natural-gas products.
4. Wood and cellulose products.
5. General service industries.

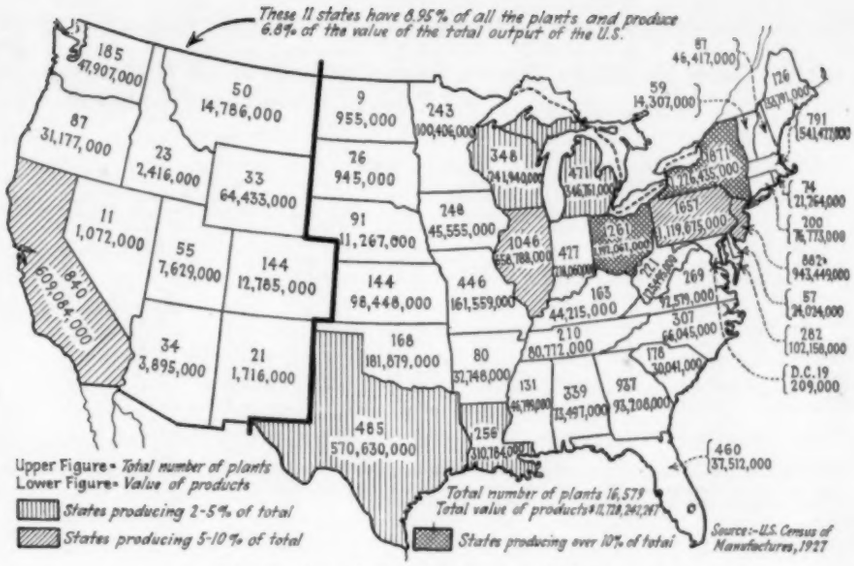
The accompanying map shows graphically the distribution of the process industries in the United States according to figures obtained from the Census of Manufactures for 1927. The process industries for the

Table I—Process Industries in the Western States Based on Census of Manufactures, 1927

Process Industries	Arizona Number of Plants	Arizona Value of Products	California Number of Plants	California Value of Products	Colorado Number of Plants	Colorado Value of Products	Idaho Number of Plants	Idaho Value of Products	Montana Number of Plants	Montana Value of Products	Nevada Number of Plants	Nevada Value of Products	New Mexico Number of Plants	New Mexico Value of Products	Oregon Number of Plants	Oregon Value of Products
Chemicals and chemical preparations	2	.....	78	$22,406,669	12	$2,115,992	1	.....	2	.....	..	.....	1	.....	2	.....
Ceramics brick and clay	8	$345,391	112	21,417,713	34	3,669,557	6	$211,739	10	$458,075	1	.....	4	$161,667	16	$643,445
Coke	..	.....	..	.....	4	.....	..	.....	..	.....	..	.....	..	.....	..	.....
Drugs and cosmetics	..	.....	142	9,853,271	18	424,643	1	.....	1	.....	1	.....	..	.....	7	159,742
Explos. and fireworks	1	.....	5	.....	2	.....	..	.....	2	.....	..	.....	..	.....	..	.....
Fertilisers	..	.....	16	3,787,196	..	.....	..	.....	1	.....	..	.....	..	.....	..	.....
Glass	..	.....	15	7,825,657	..	.....	..	.....	..	.....	..	.....	..	.....	..	.....
Gel., glue, adhesives	..	.....	8	.....	..	.....	..	.....	..	.....	..	.....	..	.....	..	.....
Leather	..	.....	16	11,026,193	..	.....	..	.....	..	.....	..	.....	..	.....	5	218,811
Lime and cement	1	.....	22	28,447,212	6	97,241	1	.....	4	.....	1	.....	1	.....	3	.....
Gas, manufactured	11	1,277,907	40	24,544,051	9	3,655,607	4	259,703	4	447,967	2	.....	2	.....	10	6,139,053
Oils and greases, animal and vegetable	6	2,272,201	42	25,241,944	10	588,825	..	.....	1	.....	..	.....	3	.....	4	.....
Paints and varnishes	..	.....	78	22,940,799	7	2,131,261	..	.....	..	.....	..	.....	..	.....	11	1,170,841
Paper and pulp	..	.....	12	13,938,098	1	.....	..	.....	..	.....	..	.....	..	.....	12	20,002,341
Petroleum ref	1	.....	54	356,910,953	4	.....	..	.....	15	8,714,956	..	.....	4	1,554,472	..	.....
Rayon	..	.....	..	.....	..	.....	..	.....	..	.....	..	.....	..	.....	..	.....
Rubber goods	..	.....	25	5,733,233	5	.....	..	.....	..	.....	..	.....	..	.....	3	.....
Soap	..	.....	45	20,245,936	8	101,673	..	.....	..	.....	1	.....	1	.....	2	.....
Sugar	..	.....	7	7,545,768	18	.....	3	.....	3	5,165,425	1	.....	..	.....	..	.....
Other proc. industries	4	.....	123	27,219,488	6	.....	7	1,944,565	7	.....	4	1,071,805	5	.....	12	2,842,861
	34	3,895,499	840	609,084,181	144	12,784,799	23	2,416,007	50	14,786,423	11	1,071,805	21	1,716,139	87	31,177,094

of the West

al Recognition


These 11 states have 6.95% of all the plants and produce 6.8% of the value of the total output of the U.S.
Upper Figure = Total number of plants
Lower Figure = Value of products
States producing 2-5% of total
States producing 5-10% of total
States producing over 10% of total
Total number of plants 16,579
Total value of products $11,778,241,241
Source:-U.S. Census of Manufactures, 1927

Distribution of Chemical Process Industries

eleven western states are tabulated in Table I, the number of plants and value of products being shown wherever possible.

In Table II the figures show the relation of western process industries to those of the remainder of the United States, as well as the "density" of plants as referred to population and area. The average size of plants is indicated by the value of products produced per plant.

All available data for the production of chemicals and allied products in the eleven western states are summarized and tabulated in Table III. These figures are for the year 1929 and are published for the first time in *Chem. & Met.* through the courtesy of the Bureau of the Census, U. S. Department of Commerce.

Production from mineral sources has been the chief instigator of western manufacturing. At first, the rarer metals attracted attention, but later other opportunities became apparent, and since that time the development of mineral resources has been constantly increasing. This work includes in addition to the mining of deposits, the chemical treatment of saline brines and sea water.

California now produces practically all of the world's supply of borax. Three principal producers operate in the Mojave desert. By the close of the present year, the American Potash & Chemical Corp. will have completed additions to its Trona plant which will then have a daily capacity of over 200 tons of borax and of almost 400 tons of potassium chloride, in addition to boric acid made from borax. The raw material is brine from wells sunk in the crystal bed of Searles Lake. The Pacific Coast Borax Co., through operation of its rasorite mines at Kramer, is able to produce an enormous tonnage of borax. This mineral is almost pure sodium tetra-borate, $Na_2B_4O_7 \cdot 4H_2O$. Some of it is processed at the mine and exported; the remainder is shipped to the refinery at Wilmington, Calif., where it is treated to give the deca-hydrate, boric acid, soap, etc. A third producer, the Western Borax Co., also is operating on the same deposit of rasorite near Kramer. A fourth producer, the West End Chemical Co., produces borax along with soda ash from Searles Lake brines.

Much effort and money have been spent in the United States in searching for a deposit of potash of such quality that the production of pure products would be commercially feasible. Due to the publicity and glamour which has surrounded German potash production, this chemical has always been attractive to capital interested in the development of natural resources. Until a few years following the War, however, the United States paid tribute to the foreign monopoly of this material. The story of the search for such deposits in this country is a romantic one; lives have been lost and several companies bankrupt in the process. It has remained for the Pacific Coast Borax Co., operating through the United States Potash Co., to discover and exploit such a deposit near Carlsbad, N. M. A large potash refinery is at present under construction on the Pecos River. With the completion of this project and with the enlargement of the plant of the American Potash & Chemical Corp., the production of potash will reach such proportions that by further enlargement it would be easily possible to make the United States self-supporting in this commodity. It is unlikely that capacities will be increased to this point until the production now planned has been carried on long enough to determine what its effect will be on prices heretofore set by the foreign monopoly. By this time further economies in production costs should be effected, so that lower prices will be feasible.

All of the soda ash produced in the western states is from natural sources. It still remains for some of the producers to manufacture a grade equal to that made in the East by the ammonia-soda process. This can be done, but research is necessary and few of the producers

	Utah		Washington		Wyoming	
	No. of Plants	Value of Products	No. of Plants	Value of Products	No. of Plants	Value of Products
Chemicals and chemical preparations	9	$370,878	20	$1,816,606	..	.....
Ceramics brick and clay	9	1,173,033	31	3,440,095	3	$98,175
Coke	2	.....	1	.....	..	.....
Drugs and cosmetics	4	.....	24	560,669	..	.....
Explosives and fireworks	1	.....	5	.....	1	.....
Fertilizers	..	.....	4	267,907	..	.....
Glass	..	.....	...	.....	1	.....
Gelatine glue, adhesives	..	.....	2	.....	..	.....
Leather	..	.....	1	.....	..	.....
Lime and cement	8	229,067	9	481,913	..	.....
Gas, manufactured	2	.....	10	4,506,512	1	.....
Oils and greases, animal and vegetable	2	.....	2	.....	..	.....
Paints and varnishes	1	.....	12	1,186,815	..	.....
Paper and pulp	..	.....	25	28,947,893	..	.....
Petroleum, refined	1	.....	2	.....	15	60,834,758
Rayon	..	.....	...	.....	..	.....
Rubber goods	..	.....	3	76,048	..	.....
Soap	1	.....	4	367,754	..	.....
Sugar	9	5,855,872	1	.....	4	.....
Other process industries	6	.....	29	6,254,475	8	3,500,164
	55	$7,628,850	185	$47,906,687	33	$64,433,097

Table II—Eleven Western States Compared to All United States in Relation of Population, Area, and Value of Products to Process Industrial Plants

State	Population by 1930 Census in 1,000	Per cent of Total U. S.	Per cent of Total for 11 Western States	Process Industrial Plants 1927	Per cent of Total for U. S.	Per cent of Total for 11 Western States	Population in 1,000 Persons Per Process Industrial Plant	Area of State in 1,000 Square Miles	Per cent of Total U. S.	Per cent of 11 Western States	Area in 1,000 Sq. Miles Per Process Industrial Plant	Value of Products in $1,000	Per cent of Total for U. S.	Per cent of Total for 11 Western States	Value of Products in $1,000 per Plant
Arizona.....	421.6	0.38	3.6	34	0.21	2.3	12.4	114.0	3.8	9.6	3.35	3,895	0.03	0.5	11.5
California...	5,642.3	4.60	47.8	840	5.06	56.6	6.7	158.3	5.2	13.3	0.19	609,084	5.18	76.4	725.0
Colorado....	1,033.2	0.84	8.8	144	0.87	9.7	7.2	103.9	3.4	8.7	0.72	12,785	0.19	1.6	89.0
Idaho.....	437.4	0.36	3.7	23	0.14	1.6	19.0	83.9	2.8	7.1	3.65	2,416	0.02	0.3	10.5
Montana....	533.6	0.43	4.5	50	0.30	3.4	10.7	146.6	4.8	12.3	2.93	14,786	0.13	1.9	296.0
Nevada.....	90.6	0.07	0.8	11	0.07	0.7	8.2	110.7	3.7	9.3	10.07	1,072	0.01	0.1	97.5
New Mexico	418.9	0.34	3.5	21	0.13	1.4	19.9	122.6	4.0	10.3	5.84	1,716	0.01	0.2	81.8
Oregon.....	951.8	0.78	8.1	185	1.12	12.5	5.1	96.7	3.2	8.1	0.52	31,177	0.26	3.9	168.5
Utah.....	502.6	0.41	4.3	55	0.33	3.7	9.1	85.0	2.8	7.2	1.54	7,629	0.06	1.0	138.7
Washington.	1,557.5	1.27	13.2	87	0.52	5.9	17.9	69.1	2.3	5.8	0.79	47,907	0.41	6.0	551.0
Wyoming...	224.7	0.18	1.9	33	0.20	2.2	6.8	97.9	3.2	8.2	2.97	64,433	0.55	8.1	1,953.0
Total.....	11,814.2	9.63	100.0	1,483	8.95	100.0	8.0*	1,188.7	39.2	100.0	0.80*	796,900	6.8	....	537.0*
					Average for U. S., 7.4				Average for U. S., 0.18						708.0

Note: Figures giving the number of plants are latest available, 1927 Census of Manufacturers, and are not quite complete, since certain data are not made available due to disclosing operations of individual establishments.

All figures to nearest decimal. *Average for 11 Western States.

are making any progress toward this goal. While the western markets can, at present, absorb the natural type of ash, there is a gradually increasing demand for a purer product of better color. At present there may not be sufficient demand to justify the installation of an ammonia-soda plant, but the type of process industries which are now being established will require a better grade of ash. If the producers of natural soda do not awake to this fact and produce a higher quality product, it is likely a large part of their market will eventually be lost through the establishment of an ammonia-soda plant.

Another possible source of alkali is byproduct production at Searles Lake. A double salt of the sulphate and carbonate of sodium is removed from the brine in the manufacture of potash. This is now being tested as a mixture of sulphate and carbonate in such industries as the making of kraft pulp. Further purification is possible should the market demand it.

Sodium sulphate also has attracted capital during the past several years and much interest has been shown in the deposits in Washington, Wyoming, Nevada, and California. Some money has been spent in this work and a few producers are operating, but on such a low-priced commodity the high freight cost due to distance from seaboard makes the prospect less attractive than it at first seems.

Sea water forms the raw material for a number of chemical plants. There are eleven salt factories, all operating in California. Some of these plants produce only crude salt, a part of which is marketed as such, while the remainder forms the raw material for the refineries and for production of electrolytic chlorine and caustic soda. There are three western electrolytic plants, two located in Washington and one in California. The residual bitterns from the production of crude solar salt form the raw material for the production of bromine and magnesium compounds. There are three bromine plants, all in California. These are under control of an eastern company and not all of them are being operated. The same company also controls a large part of the magnesite production, as well as a barium products plant. Magnesium compounds are being manufactured by another California producer. Colorado capital is reported to be supporting a project for producing barium and magnesium products near Pueblo.

After years of development work, a process has been perfected by which alginic acid and its salts are being made in a very pure form from kelp harvested in the Pacific Ocean. These compounds are especially useful as protective colloids in the food and other process industries. A plant for the manufacture of agar agar from sea moss is also located in California. The product is the finest grade of agar agar on the market today. In addition to its industrial uses, it is replacing animal gelatine in food preparations.

With the entrance of the Royal Dutch Shell interests into Pacific Coast chemical production, the western states show an increased daily production of synthetic ammonia of at least 30 tons of fixed nitrogen. It is probable that solvents and other chemicals will be manufactured later. At present most of the ammonia is being used to make ammonium sulphate for fertilizer, or is oxidized to nitric acid for explosive manufacture.

The business depression has made it more than evident that the flush days of easy money in the petroleum industry have passed. Several disastrous price wars have made the oil companies anxious to diversify their products. Laws enacted in California regarding wastage of natural gas have pointed the way to such diversification through the use of this product as a raw material. As in other parts of the United States, the pipe-line systems for natural gas are being rapidly extended and the opportunity to use such fuel is greatly benefiting western industry. Compressed gas is being shipped in cylinders and tank cars to supply communities where natural gas is not available.

Production of petroleum and its refining form the most important process industries for the states of Montana, Wyoming, and California. The value of the petroleum products of California is almost 60 per cent of the value of products produced by all process industries. In Montana and Wyoming, the percentages are 59 and 94, respectively.

Disposal of the brine solutions which are produced along with the crude petroleum from the wells has been a very interesting problem in the southern part of California. It has been successfully solved and the treating plant rendered practically self-supporting through co-operative operation and the sale of the recovered oil (see *Chem. & Met.*, September, 1931, p. 537). One development of considerable importance is the production of iodine from such brines. This is now being commercially practiced by one plant in California, which is making several hundred pounds daily. These brines also

have possibilities as raw materials for the production of other chemicals.

The paper and pulp industry in the Northwest has, during the past several years, undergone extremely rapid expansion. This has resulted in a condition of overproduction especially noticeable during the present depression, and several mills have been shut down for the time being. A grade of pulp suitable for the manufacture of rayon is an accomplishment of one of the northwestern plants. The establishment of a rayon plant on the Pacific Coast appears to be a commercial opportunity worthy of investigation. The pulp mills in the Northwest are well designed and have developed a fine technology.

Space does not permit a detailed treatment of the service industries. The production of cement, rubber goods, drugs, soaps and detergents, explosives, ceramics, sugar, leather, glass, animal and vegetable oils, paints, inks, etc., forms an active and important part of the process industries in the West. Crude rubber is being produced at Salinas, Calif., from the guayule shrub.

Fabrication of iron and steel is a well developed western industry, but the production of the primary products has not made such good progress except in Utah. The cost of transporting coke from Utah or the East to the Pacific Coast has led some of the petroleum producers to experiment with oil as a raw material for manufacture of coke. The results obtained have been very encouraging and it is possible that the metallurgy of several metals will be aided by petroleum coke in the near future.

The abundant power resources of the Pacific Northwest are being developed, and this presages an increase in the number of electrochemical industries there.

In most western states, agriculture is a principal industry. Because of overproduction of practically all agricultural products in the United States, producers in the western states are placing more and more emphasis on the marketing of only first-grade agricultural products and utilizing the remainder in the manufacture of by-products and for raw materials in the process industries. This part of the industry is just in its infancy and no doubt will grow very rapidly especially since the cooperatives are so closely interested.

In the equipment field, new and valuable tools for the chemical engineer developed by western industry include evaporators, spray dryers, dust collectors, meters, control instruments, samplers, feeders, valves, and viscosity control apparatus. These for the most part present unique features not found in existing instruments and apparatus and in addition satisfy the demand of western industry for quicker delivery.

The "Western Empire" is now in an interesting stage of its industrial development. Although its growth has been retarded somewhat by political conditions in the Orient and by the world depression, it has a bright future in which the chemical engineer is destined to play an important part.

Table III—Chemicals and Allied Products in Eleven Western States

(Census of Manufactures: 1929)

Industry	Number of Establishments	Salaried Employees	Wage Earners (Average for the Year)	Salaries	Wages	Materials, Containers for Products, Fuel, and Purchased Electric Current	Fuel and Purchased Electric Current	Products	Rated Horsepower Motors Driven by Prime Movers	Rated Horsepower Motors Driven by Purchased Current
Arizona										
Oil, cake, and meal, cottonseed	6	58	2,174	136,762	169,673	2,083,998	92,190	3,459,915	625	2,008
California										
Alcohol, ethyl	4	32	1,441	100,755	191,674	1,130,284	107,773	2,311,280	1,405	1,211
Blacking, stains, and dressings	12	30	494	62,424	41,410	218,958	2,555	499,526	...	186
Chemicals, not elsewhere classified	48	473	25,821	1,189,058	3,438,495	9,994,365	1,822,924	24,636,002	2,037	26,438
Cleaning and polishing preparations	34	53	1,043	100,238	115,931	411,659	4,563	962,474	...	292
Compressed and liquefied gases	24	229	2,577	450,480	334,651	973,657	176,835	3,514,556	276	3,818
Druggists' preparations	22	71	1,940	166,029	179,947	653,173	11,300	1,752,705	...	190
Fertilizers	21	101	3,621	322,114	390,970	3,595,281	58,398	5,517,940	270	3,146
Glue and gelatin	5	11	1,020	35,985	120,109	549,477	30,216	818,775	134	506
Grease and tallow, not including lubricating greases	19	45	3,881	112,744	488,311	2,642,701	85,740	3,905,864	225	2,519
Ink, printing	6	42	1,546	101,212	184,784	1,040,955	29,714	1,496,997	...	1,551
Liquors, vinous	15	34	1,738	209,883	218,451	380,541	23,983	1,735,598	182	851
Mucilage, paste and other adhesives, except glue and rubber cement	9	8	240	23,749	25,182	239,903	1,584	441,841	8	15
Oil, cake, and meal, cottonseed	8	49	1,979	153,004	198,702	2,865,407	93,421	5,142,500	...	4,422
Oils, not elsewhere classified	14	111	5,821	307,237	898,117	18,212,063	240,508	21,235,290	155	6,922
Paints and varnishes	82	650	16,974	1,588,775	2,198,041	15,859,080	256,607	26,393,866	30	9,756
Patent and proprietary medicines and compounds	117	347	7,787	1,013,235	794,622	4,467,528	48,138	10,215,968	60	2,067
Perfumes, cosmetics, and other toilet preparations	55	120	2,436	310,833	197,910	1,123,951	4,812	3,094,169	...	206
Salt	11	55	5,296	190,463	657,863	946,864	141,703	3,668,108	1,350	4,169
Soap	33	372	7,474	946,074	845,156	10,628,949	118,019	19,842,049	748	3,586
Colorado										
Chemicals, not elsewhere classified	3	13	618	41,691	62,395	448,058	28,177	751,138	65	824
Cleaning and polishing preparations	7	13	120	34,391	13,118	46,231	416	119,130	...	14
Druggists' preparations	6	12	278	43,475	30,792	118,899	3,008	316,258	...	29
Grease and tallow, not including lubricating greases	6	14	655	38,474	69,828	287,516	16,327	509,205	185	536
Paints and varnishes	5	17	775	48,474	88,779	629,419	8,546	1,101,579	...	393
Patent and proprietary medicines and compounds	10	29	258	52,988	22,173	142,396	1,465	344,368	...	31
Perfumes, cosmetics, and other toilet preparations	5	6	72	10,155	3,925	23,172	416	73,240	...	6
New Mexico										
Oil, cake, and meal, cottonseed	4	17	879	23,100	41,229	783,421	19,078	1,133,590	1,155	298
Oregon										
Cleaning and polishing preparations	3	1	24	2,000	2,300	10,250	70	22,798	...	5
Compressed and liquefied gases	4	20	161	26,256	21,436	29,320	16,037	207,362	...	457
Paints and varnishes	12	23	1,531	40,082	163,326	935,588	7,784	1,450,738	...	442
Patent and proprietary medicines and compounds	10	10	274	12,825	22,471	103,778	1,352	228,082	15	111
Utah										
Compressed and liquefied gases	5	29	343	59,751	42,310	103,034	32,322	353,497	720	461
Washington										
Chemicals, not elsewhere classified	6	51	1,439	104,256	195,625	482,721	138,733	1,308,760	225	4,785
Compressed and liquefied gases	8	50	560	94,374	79,162	186,914	41,794	688,174	...	754
Fertilizers	3	13	283	34,330	23,645	227,357	3,613	402,704	75	115
Paints and varnishes	11	50	1,525	125,190	168,811	865,265	12,219	1,709,274	...	683
Patent and proprietary medicines and compounds	16	35	595	67,686	53,246	325,109	6,758	658,155	100	126
Soap	4	14	430	33,730	47,792	412,566	2,946	569,941	80	264

A lowly byproduct—sulphuric dioxide in smelter fume—and cheap hydro-electric power underlie the whole impressive development at Trail, B. C. To utilize sulphuric acid from a modern contact plant, a new wet-process phosphoric-acid unit was built. To utilize a part of this output as ammonium phosphate, a new synthetic ammonia plant was built. To utilize cheap power, electrolytic cells were selected as a source of hydrogen. So begins the chain of utilization and interrelation that may well develop into Canada's largest chemical industry.

Pioneering Chemical and Fertilizer Production in

By S. D. KIRKPATRICK
Editor, Chem. & Met.

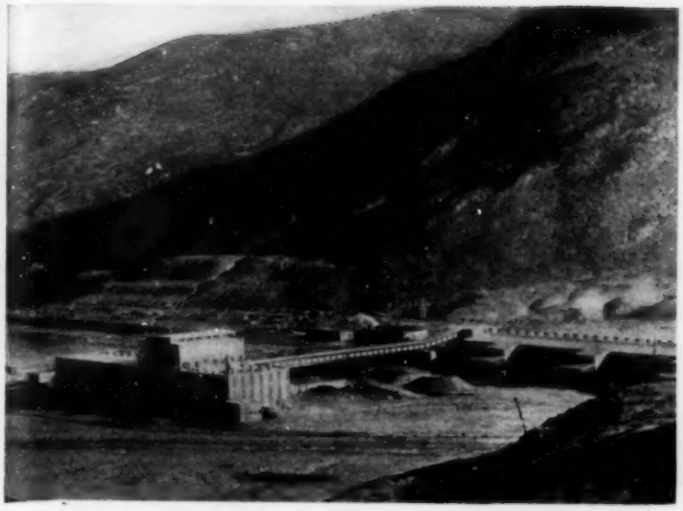
SUCCESS in any chemical industry is largely a matter of "M's." First there must be *money*, then *men* and *materials*, *methods* and *machinery*, and finally, if the project is to be profitable, there must be proper *markets* and *merchandising methods*. Without attempting to carry this alliteration further, it is interesting to see how the new chemical and fertilizer program of the Consolidated Mining & Smelting Co. of Canada, Ltd., measures up to these requirements. For more than a year this great metallurgical organization has been engaged in the construction at Trail, B. C., of what probably is destined to be the largest coordinated chemical enterprise in Canada. Built around a daily production of 375 tons of 100-per cent sulphuric acid are complete plants to produce between 300 and 400 tons per day of ammonium sulphate, mono-ammonium phosphate, and triple superphosphate. They will cover an area of 60 acres, employ about 300 men, and require approximately 34,000 hp. of electrical energy.

When the project is completed, it will have called for an expenditure of more than $10,000,000. This vast sum is, however, only about one-fourth of what the company has expended since 1919 on its plants and for the purchase of new properties. It is less than a seventh of the net profits accumulated during this period. Thus the matter of *money* has already been adequately provided. And the company is equally fortunate in the *men* who are to carry the responsibility for this great project. J. J. Warren, outstanding Canadian industrialist and president of Consolidated, has placed at the head of the whole chemical and metallurgical organization at Trail, Selwyn G. Blaylock, vice-president and general manager, who began his career as an assayer at the Trail smelter immediately after he was graduated from McGill University in 1899. Later he became chief chemist, then metallurgist, smelter superintendent, manager of the St. Eugene and Sullivan mines, and was assistant general manager of the Consolidated until 1919, when he became general manager and subsequently vice-president and director.

When the plans for the chemical program got under way, the man selected as general superintendent of the new chemical and fertilizer department was Ralph W. Diamond, graduate metallurgical engineer, who, as superintendent of concentration, had been eminently successful in carrying out some of the company's largest and most difficult technical developments. In pioneering into the new field, the management was also able to draw heavily on the experience of another of its executives, E. M. Stiles, chief engineer, who had been responsible for much of the new expansion and construction programs.

In building the production organization, with which this article is chiefly concerned, Mr. Diamond has surrounded himself with a splendid group of chemical engineers, selected almost entirely from the Consolidated staff. He is directly assisted by A. L. McCallum, assistant general superintendent and superintendent of the acid department, and by C. H. Wright, superintendent of the development division. The superintendents of the principal product divisions of the chemical department are W. S. Kirkpatrick, in charge of hydrogen (who also serves as chairman of the general works committee); E. A. G. Colls, in charge of synthetic ammonia; W. D. Burgess, of the phosphate plant; and A. M. Chesser, of ammonium sulphate and storage. James Atwell, assistant superintendent, controls operations of the sulphuric-acid division under Mr. McCallum. In charge of the three important service divisions are G. H. McKay, mechanical; B. P. Sutherland, chemical; and J. F. Millican, plant testing.

Of the *materials* on which the chemical project is based, sulphuric acid, made from the waste gases of the smelters, is present in most abundance. In fact, a motivating force in this whole



Ten Millions Is Being Spent in Building This Great Coordinated Chemical Industry at Trail, B. C.

Western Canada

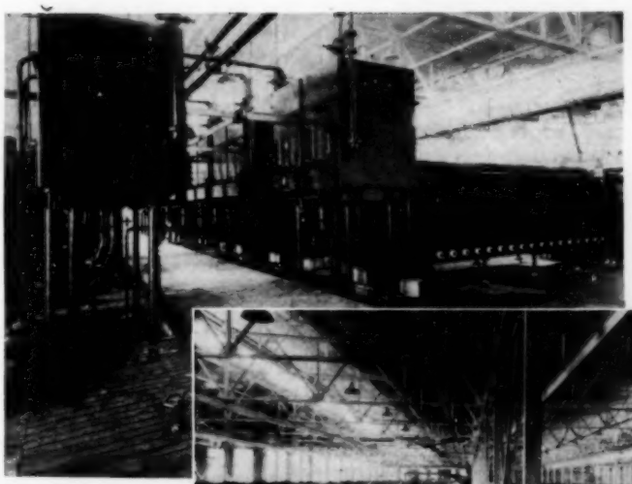
expansion program was the attempt to utilize as large a proportion as possible of the sulphur dioxide now liberated in its stacks. The other primary raw material, phosphate rock, is available on company property at Crow's Nest, near Fernie, B. C., but better grade material is being brought from deposits at Garrison, Mont., and near Paris, in southeastern Idaho. About 450 tons of rock is required for a single day's operations.

To make certain that *methods* and *machinery* are the best that modern technology has developed, Messrs. Blaylock, Stiles, Diamond, Colls, and others have fully investigated European and American practice and have had the benefit of the consultation of leading engineers and equipment manufacturers. More will be said later of the technical facilities and operating methods of the new plant.

Of the seven "M's" only *markets* and *merchandising* remain, and these certainly have not been neglected. Systematic experimentation in the prairie provinces of Canada during the last three years has definitely shown that the use of concentrated fertilizers would be of great economic advantage to farmers of that region. In this study the company has had the cooperation of the dominion and the provincial departments of agriculture, the colleges and universities, the Canadian Pacific, the National Research Council, farm machinery groups, and various other agencies. A large staff of agronomists and agricultural specialists under Dr. R. E. Neidig's direction have supervised exhaustive field tests in thousands of experimental plots in Manitoba, Saskatchewan, Alberta, and British Columbia. Increased yields of wheat ranging from 18 to 50 per cent were noted in some experiments in Manitoba.* Equally important is the earlier maturity, with consequent lessening in the loss due to frost, rust, and weeds. With this virgin domestic market and with a growing demand for concentrated fertilizers from the Orient, the company is now building a sales organization to merchandise its products either directly to the consumer or through sales agents in various parts of the world. President Warren has a personal interest in this phase of the program and has done a great deal to advance the agricultural research and sales development work.

Power, particularly if it is cheap and abundant, also is an important element in the success of any chemical venture. Consolidated is especially fortunate in

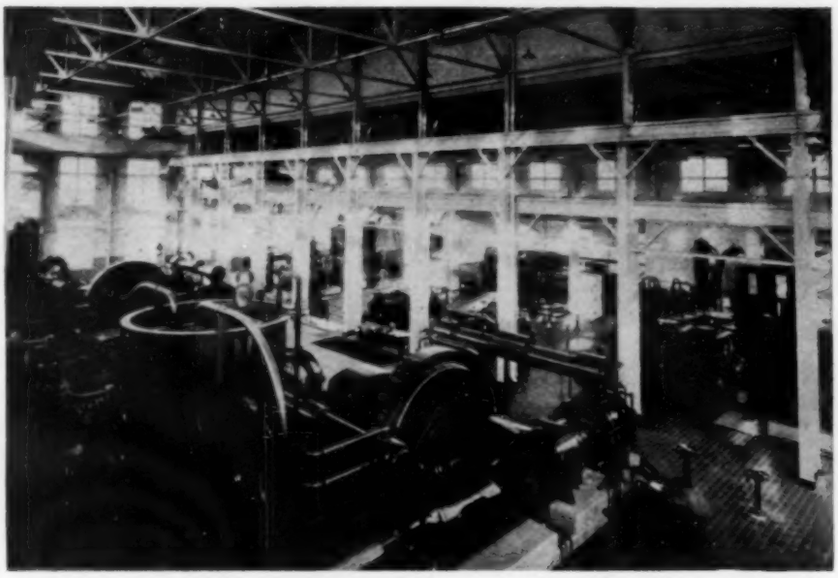
*The government reports on these fertilizer trials have been reprinted in a small booklet which is available on request to the fertilizer department, the Consolidated Mining & Smelting Co. of Canada, Ltd., Regina, Sask.



Pechkrantz Hydrogen Cells *above* Fauser and Knowles Cells *below*

Where Electrolytic Hydrogen Demonstrates Its Advantages for Ammonia Synthesis

this regard—in fact, cheap power largely made possible the huge electrolytic zinc refinery at Trail. At Bonnington Falls, on the Kootenay River, the West Kootenay Power & Light Co. (which is owned outright by Consolidated) has two power plants with generator capacity totaling 82,500 kva. and hydro turbines developing 98,000 hp. At South Slocan, on the same river, the company has a generator capacity of 52,500 kva. and hydro turbines of 75,000 hp. The latest constructional development on the river was started in 1930 at Corra Linn Rapids, and when completed it will bring the total installed horsepower to 224,000. Waste heat boilers at the slag retreatment plant of the lead smelters supply all of the process steam requirements of the chemical and fertilizer operations.



Compressor Room and Control Station for Synthetic Ammonia Plant

The Sulphuric Acid Nucleus

Because sulphuric acid was the first and is basically the most important chemical produced at Trail, these operations will be discussed first. In 1928, a modified Grillo type of contact plant was installed and has since produced continuously at the rate of 39 short tons of 100 per cent acid per day. A conversion efficiency of 96.5 per cent is being obtained by the use of platinum masses distributed on magnesium sulphate and asbestos. Three new units, each of 112 short tons capacity, have just been completed to bring the total plant capacity to 375 tons. These units, using vanadium catalysts, represent the most modern practice in acid-plant construction.

The gas from the zinc roasters, containing about 6½ per cent of sulphur dioxide, reaches the acid plant at a temperature of approximately 750 deg. F. Here it is completely purified to remove flue dust, arsenic compounds, sulphuric acid mist, and water vapor. To accomplish this it passes first through hot Cottrell plate-type precipitators and is cooled to about 150 deg. F. by being scrubbed with weak acid in Glover towers, of which there is one for each of the four units. These lead shells are about 20 ft. in diameter and 25 ft. high, brick-lined and packed. The cooled gas passes out to a header in the main flue, which is made of lead and is about 4 sq.ft. in cross-section. Branches from this flue supply each of the units.

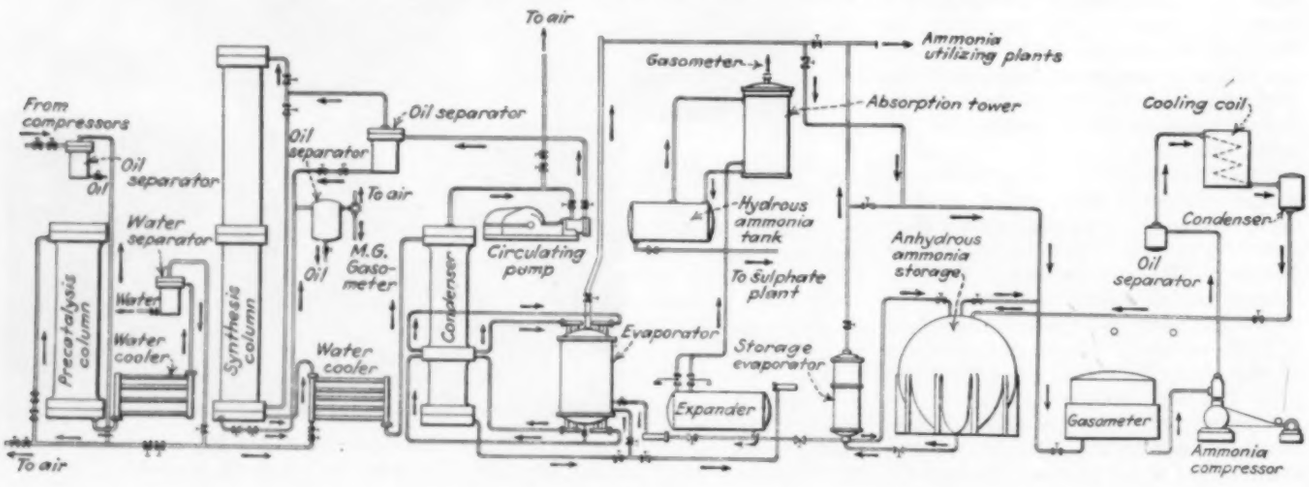
As the gas enters the unit it is washed with water in towers of the same size and construction as the Glovers, passed through Cottrell mist precipitators of the lead pipe and wire type, and is ready for drying. The first, or weak drying, tower is of all lead construction, since acid of about 80 per cent concentration is used to dry the gases. It is distributed over the top of the bricks in the column by 13 nozzles each provided with concave splash disks. The acid passes through the tower into a cooler and is then recirculated. The second, or strong drying, tower is of steel, tile lined and filled with coke instead of brick. The acid used is 98.5 per cent, which is distributed in the tower and recirculated in the same manner as the weaker acid.

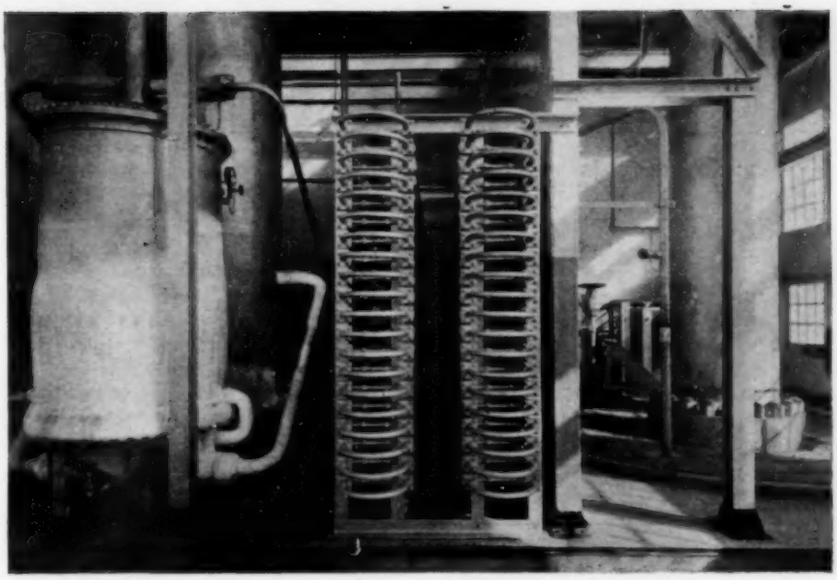
Acid mechanically entrained in the gas is removed in coke filters, which are lead boxes about 20 ft. square and 10 ft. in height. Then Elliott turboblowers capable of handling 17,000 cu.ft. per minute carry the gas to the converters at a pressure of 2 or 2½ lb. There are two blowers for each unit, so that one may be held as a spare. They are driven by 350-hp. 2,200-volt induction motors.

Before reaching the catalyst, however, the gas must first pass through tubular heat exchangers, where it is heated by the exit gases, so that it enters the converter at about 540 deg. F. It leaves at about 720 deg. F. The converter holds 347 pipes of about 4½ in. in inside diameter which are filled with the vanadium catalyst. At the bottom is a tray on which there is a layer of about 18 in. of catalyst. In all, each converter requires approximately 10 tons of catalyst.

The SO_3 leaving the heat exchanger is further cooled by air and then passes

Schematic Diagram and Flow Sheet for Ammonia Synthesis by the Fauser Process





Ammonia Synthesis Column *on right*
Condensing Equipment *on left*

into the absorption towers, which are of steel with tile lining and packed with quartz. These are 25 ft. high and about 15 ft. in diameter. Coal-fired preheaters are provided to bring each converter up to temperature at the start of operation.

The absorbing acid is of 98.5 per cent concentration as it enters the top of the tower, and when drawn off at the bottom sufficient water or acid is added to bring it back to this strength. After cooling in cast-iron pipe coolers, over which water is circulated, the acid flows to the absorption pump tanks. On the opposite side of the absorber there is another tap from which the strong acid is drawn off in quantities determined by the level in the absorption pump tank. This represents the acid "make" of the plant, which when diluted to 93 per cent is run to one of two 2,100-ton steel storage tanks. From here it is pumped in a 4-in. line to the fertilizer plant about a mile away. Despite a 400-ft. lift, two small 4-stage centrifugal pumps of Allis-Chalmers manufacture are each capable of delivering about 1 ton of acid per minute. They are each driven by 50-hp. induction motors.

Each scrubbing tower, each drying tower, and each absorber is equipped with Lewis glandless centrifugal acid pumps capable of handling 50 to 100 tons per hour. These are direct-driven by 15- to 25-hp. Canadian G. E. motors.

Each of the acid units will employ nine men; i.e., three per shift. Controls are provided for testing incoming and exit gases. Republic pyrometers indicate the temperatures at eight places in each of the converters. Other controls are provided to give a minimum of manual operation.

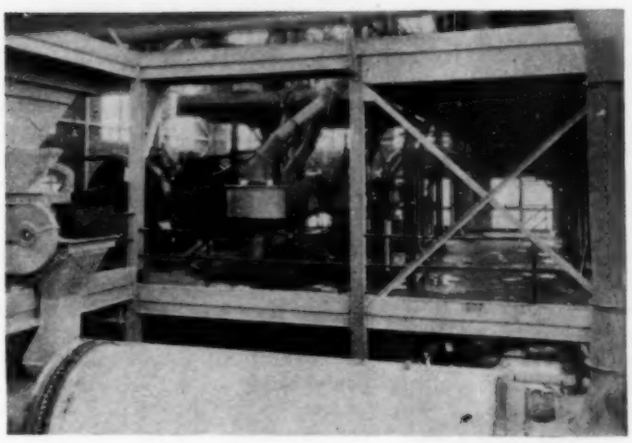
Because sulphuric acid and cheap electrical energy are Consolidated's chief assets, its main objectives, from a chemical standpoint, might well be defined as an effort to sell acid in the form of phosphates and power as nitrogen compounds. Therefore it is logical that its synthetic ammonia plant should obtain its hydrogen by the electrolysis of water. Furthermore, since this may eventually represent one of the largest installations of its kind in the world, the management has wisely decided to try out several types of electrolytic cells. This first plant is something of a test on a grand scale of the parallel operation of the Knowles, Fauser, Pechkrantz, and Stuart cells.

The complete installation consists of 900 cells, 10,000 amp. each and requiring 21,000 kw. for their operation. They have a total rated capacity of 3,148,000 cu.ft. of hydrogen and 1,574,000 cu.ft. of oxygen. At present the latter is wasted to the atmosphere, although eventually it may well serve as the basis for important metallurgical developments.

The cells are of two general types of construction. The Knowles, Fauser, and Stuart cells are of the bell type, connected in series with electrodes in parallel. The Pechkrantz cell, however, is of the filter-press type with its electrodes in series and the cells paralleled across the circuit.* Electrical energy received at the plant as 60,000 volt a.c. is transformed to 650 volts and then converted to d.c. in three mercury arc rectifiers, each of 10,000 amp. Two of the units are of Brown-Boveri construction and the other was made by General Electric Co. The mercury-arc rectifier has been used satisfactorily in the electrolytic zinc plants of the company, but the present installation is the largest of its kind on the American continent.

The interior of the hydrogen building, as shown in the accompanying illustrations, is most impressive. Complete air washing equipment has been installed in order to keep the atmosphere entirely free from dust. The Sirocco unit used is capable of changing all the air in the plant every 15 minutes.

The hydrogen from the cells is generated at a pressure equivalent to 3 in. of water, which is boosted to 10 in. by Bryan-Donkin blowers made in Chesterfield, England. These force the gas into the hydrogen gasometer, which has a capacity of about 425,000 cu.ft.



Saturators, Centrifuges, and Dryer in Ammonium Sulphate Plant

Nitrogen is produced in two Claude liquid-air units, each of which will handle 1,850,000 cu.ft. of air per day, producing about 1,340,000 cu.ft. of 99.9 per cent nitrogen. The units are connected for interchangeable operation either in their entirety or in the individual parts. Otherwise the operation proceeds according to standard practice. The air enters through the oil filter at the first stage of a 3-stage Swiss compressor of Burckhardt manufacture, and is here compressed to 20 atmospheres. Carbon dioxide is removed in a soda-scrubbing tower and the air is dried by passing it through a battery of four towers in series which are filled with solid caustic soda. The dried air, cooled by the outgoing nitrogen, passes to the liquefiers, where about 20 per

*A more detailed description of this cell will appear in an article in an early issue of *Chem. & Met.*

cent is liquefied. The remainder goes to the expansion engine, where it is expanded to obtain the double cooling effect of expansion and external work which is used to compress a portion of the air between the second and third stages of the Burckhardt compressor. The liquid air is fractionated in a copper rectifying column, 30 ft. in height, insulated with mineral wool and inclosed in a wooden case. The nitrogen is passed to the gasometer of about 100,000 cu.ft. capacity.

For the ammonia synthesis, the well-known process developed by Dr. Giacomo Fauser, of Novara, Italy, is being used (see the accompanying flow sheet). The plant has a rated capacity of 47 tons of anhydrous ammonia per day and a standby unit of same rating also is installed. The nitrogen and hydrogen are drawn from storage in the approximate proportions of 1 to 3 and are mixed in Bryan-Donkin mixers. These are of the rotary blower type in which four blades slide in slots on an eccentrically placed shaft, thus forming valves for the intake and discharge of the gases. The mixture is analyzed and the proportion corrected by a bypass. The blower discharges to the mixed gas gasometer, which has a capacity of 140,000 cu.ft.

Two 6-stage Canadian Ingersoll Rand compressors are used to bring the gas to a maximum pressure of 300 atm. Each will handle about 250,000 cu.ft. per hour and is driven by a 2,250-hp. synchronous motor.

Gas from the sixth stage of the compressor passes through an oil separator into a common header between the two compressors and thence to the pre-catalyst group for purification. With electrolytic hydrogen practically the only impurity is oxygen, which usually is present in the mixed gases in an amount less than 0.2 per cent. The purification is effected with copper Raschig rings in a column about 25 ft. high, 3 ft. in diameter, and 6½ in. in wall thickness. This forging of nickel steel was made by the English Steel Corp., of Sheffield, which fabricated all of the pressure vessels for this ammonia plant.

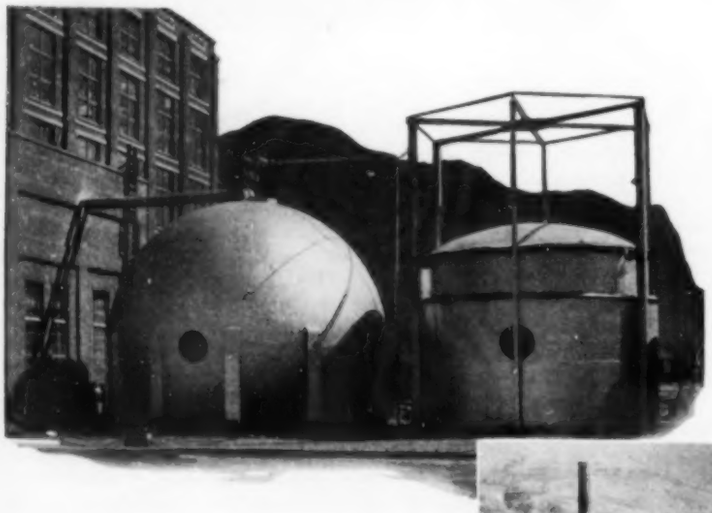
After cooling in a water-jacketed high-pressure pipe cooler, the gas enters a water separator and then passes into a common header supplying the four synthesis groups. This so-called new gas is used to make up the volume of ammonia later removed from the system by condensation.

Each of the synthesis groups is served by a Breda circulating pump made in Milan, Italy. This is a 2-cylinder, double-acting pump, driven by a 125-hp. variable-speed motor. It sends the gas at a pressure of 200 atm. first through another oil separator (to remove any last traces of carbon that might otherwise poison the catalyst) and then into the converters or catalyst chambers. These are about 50 ft. high, 3 ft. in diameter, and with 6½-in. walls. They are made in halves of nickel steel, flanged and bolted together, and set in pits 25 ft. in depth.

The catalyst chamber is heated electrically during the start of operations by iron heating elements arranged in a spiral around the converter. A 250-kva. transformer with a tap switch made by the Packard Electric Co., of St. Catherine, Ont., permits the application of heat in the various sections of the converter.

The purified gas mixture enters the catalyst column after passing through a heat exchanger, where it is heated by the outgoing gases. The outlet gases contain about 12.5 per cent NH_3, which corresponds to about 23 per cent conversion. The operation is controlled by Budenberg gages and manometers and Republic electrical pyrometers on the main operating panels in the compressor room. The gas from the converter enters a water cooler, where it meets the incoming new mixture, and about 66 per cent of the ammonia is condensed here. It then passes to a condenser column 25 ft. high and 3 ft. in diameter, insulated with 8 in. of J-M rock cork. The gas leaves the condenser to enter the evaporator, passing through a serpentine immersed in liquid ammonia. Here it is cooled to the point of condensation, the ammonia thus providing its own refrigeration. The uncondensed gases from the condenser go back to the suction side of the Breda pump and the gas from the liquid ammonia in the evaporator passes into a common header fed by the storage evaporator. Eventually it goes to storage or to the fertilizer plants.

The liquid ammonia from the bottom of the condensers is discharged to an expander, which is a drum about 15 ft. long, 3½ ft. in diameter, and insulated with 10 in. of rock cork. An automatic regulator releases the pressure from 200 to 15 atm. This also serves to free the ammonia of argon and dissolved nitrogen and hydrogen, which are insoluble at the reduced pressure. The liquid anhydrous ammonia is stored in a Horton sphere, 30 ft. in diameter, which also is insulated with 10 in. of rock cork. Ammonia evaporating from this tank is sent by way of a small ammonia gas gasometer through a Carbondale refrigerating machine and thus returned to liquid storage.



Above: Horton Sphere and Gas Holder at the Ammonia Plant

Below: Looking Down at the Three New Contact Acid Units at Trail

Ammonium Sulphate and Fertilizer

Approximately 150 tons per day of ammonium sulphate is produced from the synthetic ammonia and contact sulphuric acid in a plant designed to use the process developed by Percy Parrish, of the Metropolitan Gas Co. of London. Another 20-ft. Horton sphere provides storage for 240 tons of 93-per cent sulphuric acid. As needed, this acid is pumped to storage tanks in the top of the building by means of Labour pumps, direct-connected to motors. Here it is diluted to 65-70 per cent, using rotometers of the positive displacement type to measure both the acid and the water. The diluted acid flows by gravity to a constant-level tank that serves the three saturators of the sulphate unit. These are of lead lined steel, each having a capacity of about 55 tons of ammonium sulphate.

Ammonia is drawn from storage

after evaporation or direct from the synthesis plant through a 12-in. pipe line. The total flow is measured by Republic recording flow meters and Bailey indicating meters to show the quantity delivered to each saturator. Meldrum steam injectors are used to carry the ammonia into the saturators at the so-called cracker pipe. The acid enters at four places around the periphery. The sulphate formed by the reaction is removed by steam injection to a common tank that serves to feed the two Haubold horizontal centrifuges, each of 80 tons capacity and driven by direct-connected 25-hp. variable-speed motors. Centrifuges are of the semi-automatic type, operating continuously. Mother liquor from the centrifuges is charged back into the saturators. The salt is discharged on an 18-in. belt conveyor, eventually elevated and split into two overhead feed bins for the dryers.

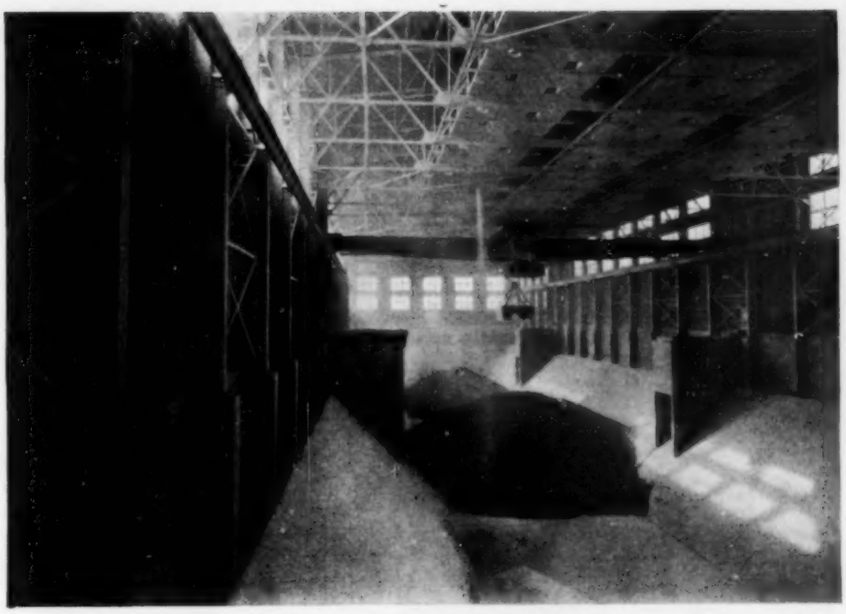
Two Pehrson dryers made in Karlstadt, Sweden, are used in this operation. They are rotary, double shells with parallel louvres through which the heated air enters and passes up through the salt. Each dryer is provided with a cyclone collector discharging on an 18-in. belt which carries the dried sulphate through a tunnel to the base of a 94-ft. elevator in the adjoining storage building. Conveyors in the top of this building provide for the final distribution of the product.

Storing the Bulk Products

This storage building is 464 ft. long, 105 ft. wide, and has been excavated about 25 ft. beneath the surface in order to provide storage capacity for 60,000 tons of the bulk products. A 7-ton overhead electric crane with a grab bucket picks up the material from the floor of the storage house and discharges it into any one of six hoppers that feed the conveyors to the shipping mills. These mills are located alongside of the storage room but at proper level to permit the carting of the bagged products directly into railroad cars on the siding that parallels the building. Each shipping mill has an elevator that carries the product to an overhead bin, from which it falls over Hum-mer screens. The oversize goes to Stedman, Jeffrey, or Sturtevant disintegrators for regrinding and is then returned to the bagging hoppers. The fines are weighed on Exact Weight scales and are bagged in paper-lined, waterproofed burlap bags. These are sewn on Union special sewing machines, dropped on hand trucks, and loaded into the cars.

Phosphoric Acid and Phosphates

In many ways the most interesting of the operations of the new plant center around the production of mono-ammonium phosphate and triple superphosphate. These products are complementary to one another, since the same equipment is used for both, and accordingly the production will depend on market conditions. The Dorr-Liljenroth process used for the manufacture of phosphoric acid is that recently developed by the Dorr Co., who have served as engineers and constructors for the phosphate plant. The new process results in the direct production of acid of higher concentration than is usually obtained by the wet method. The plant consists of three units, each having a capacity to leach 150 tons of rock phosphate per day. Contiguous with the three phosphoric-acid units are three fertilizer units each of which can be used interchangeably for either triple superphosphate or mono-ammonium phosphate.



Where the Finished Products—Triple Superphosphate and Diammonium Phosphate—Are Stored

By excavating more than 20 ft. beneath the surface and carrying the walls to a total height of about 60 ft., this building, 464x105 ft., was given storage capacity for 60,000 tons of bulk products.

Phosphate Rock From U.S.A.

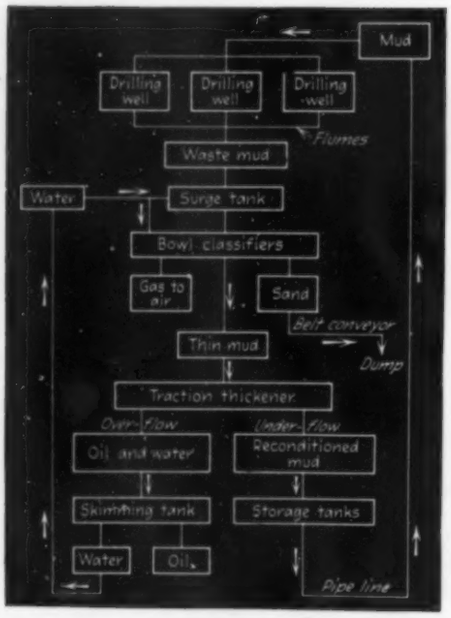
Phosphate rock is shipped in by rail from either Garrison, Mont., or Paris, Idaho. Received at the company's coarse crushing plant at Tadanac, it is crushed with gyratory and rolls to minus $\frac{3}{4}$ in. Then, in 22-ton lots, it is transported in a ten-wheel motor truck to the stockpile at Warfield, a mile from the crushing plant. Directly beneath the stockpile is a tunnel with belt conveyor into which the rock for use in the phosphate plant is caved through chutes. From the conveyor it is carried up to a bin by an 80-ft. belt and bucket elevator. A Stephens-Adamson elevator and sampler then takes the rock over a Merrick scale, where it is weighed, and distributes it to the plant bins, of which there are three for each unit, each holding 150 tons.

The phosphate plant cannot as yet be described in the same detail as the acid, hydrogen, and ammonia divisions. It includes, however, many unique and intensely interesting features which, it is hoped, will be the subject of a subsequent article in *Chem. & Met.* The severe corrosion problems involved in handling the phosphoric acid of various strengths have been satisfactorily solved by the use of KA$_2$M alloys. Lead- and rubber-lined equipment also is used in many places. The 4-in. Wilfley pumps used for circulating the pulp from the Dorr agitators are rubber-lined with KA$_2$M impellers and follow plates. The 75-ton pebble mills, 7 ft. in diameter and 16 ft. long, in which rock is ground with phosphoric and sulphuric acids, are first rubber-lined and over this surface there is another lining of 1-in. maple planks and finally on top of these are 4-in. Silex blocks. Flint pebbles are used. An ingenious method of controlling the proportion of the acid and rock has been worked out by having the Shaeffer poidometers that feed the pebble mills operated on the same drive shaft that operates the Howard acid feeders. The adjustment is made through a Reeves variable-speed transmission with Cleveland gear reduction.

Program Completed in Two Years

It is especially significant that this whole expansion program has been carried through to completion in less than two years. To accomplish this undertaking has required not only tremendous physical and financial resources but also great technical skill and business ability on the part of management. That it is but the beginning of a much greater chemical development in Western Canada is practically certain. In this direction the Consolidated Mining & Smelting Co. of Canada, Ltd., is pioneering with the same spirit and enterprise that have carried it to its leading position among the metallurgical industries of the world.

The processing of mud fluids used in rotary drilling includes some of the most important applications of the principles of chemical engineering and physical chemistry in the production of petroleum



Mud Reconditioning Flow Sheet of Associated Oil Co. Plant at Ventura, Calif.

Chemical Engineer's Rôle in Oil-Well Drilling

By MARION E. DICE
Research Engineer
General Petroleum Corp., of Calif.
Los Angeles, Calif.

One may not doubt that somehow Good
Shall come of Water and of Mud;
And sure, the reverent eye must see
A purpose in Liquidity.
—Rupert Brooke, "Heaven"

IN speaking of the processing of mud fluids in rotary drilling Alexander Duckham, vice-president of the Institution of Petroleum Technologists has said, "I know of no other opening on the actual oil field which has offered such scope for chemical assistance." Clay and other mud materials account for up to 25 per cent of the cost of a completed well. In addition to savings in direct costs, mud treatment has substantial insurance value in preventing gas blowouts and lodged drill pipe, with subsequent damage to the well and equipment.

At an individual well the mud circulating system begins at a mud pit or circulating tank, from which pumps deliver the fluid at pressures frequently as high as 1,500 lb. per sq.in. through a flexible hose and swivel joint into the rotating drill stem. The mud passes down through the drill stem, out through openings in the pit at the bottom of the hole, and upward in the annular space between drill stem and walls of the hole. At the surface again it flows at a slow rate through a series of flumes, ditches, or sumps where sand should settle out and gas escape, the mud returning to the circulating tank. It is discarded or reconditioned when the non-separating sand and gas contents become excessive.

Rotary mud usually is made from natural clays. In many cases, the well "makes" its own mud; in others, suitable materials must be hauled long distances. Four of the principal California clay deposits have been described by E. P. Tallant (A.P.I. Prod. Bull. 207, June 30, 1931). Two are in the Mojave Desert, one on Frazier Mountain, and one near Los Angeles harbor. The cost of mud materials in this region, according to Hallan N. Marsh (Trans. A.I.M.E., 1930), averages $13 per rig per drilling day, or about $2,000 per well. Averages from other sources run from $1,200 to $10,000 per well. March reports unit costs varying from 10 cents per barrel of mixed mud where suitable clay is close at hand to $1 where long hauls are involved, and on up to $11 per barrel where heavy weighting materials must be used.

Chemical control of drilling mud began only a few years ago, when the importance of its colloidal properties became apparent. Density control goes back a few more years, but the interrelation of viscosity and density was not understood until the problem was approached from a colloid standpoint. Although a substantial beginning has been made, full control awaits the development of practical technique and rugged equipment for use at the well. If wells are to be drilled to 15,000 ft., it probably will be necessary to assign a capable engineer to each drilling crew, but at present, efforts are being made to find methods which can be added to the driller's already large bag of tricks.

Mud has various duties to perform at different stages of drilling. For this reason it is impossible to generalize regarding its properties. The first purpose of the mud stream is to remove cuttings as fast as they are formed by the drill. This is largely a function of velocity, which should vary between a rate just sufficient to float the particles and one which begins to scour the sealing film from walls. Since the resultant upward movement of particles equals the linear velocity of the mud stream with respect to the walls minus the settling rate, it would seem advantageous to minimize settling. Stokes' law indicates that a high fluid density and high viscosity retard settling. However, these qualities also retard the separation of sand and gas outside the well

and therefore are not really desirable. Settling usually may be counterbalanced by slight increase in mud rate, and as a matter of fact a linear upward velocity of one foot per second is ample to float the largest particles.

Another essential function of mud fluid is to provide sufficient pressure to prevent the inrush of gas, oil, and water before the well is completed. Density is the most important property in this case.

In order to prevent a reversal of the essential outward pressure gradient from the well it is important to provide a generous excess of hydrostatic pressure. Too small differential may make it impossible to increase the density fast enough when required to prevent gas from bubbling into the column. Each bubble reduces the average density and the total hydrostatic pressure, thereby permitting more bubbles to enter. The process is cumulative and may lead quickly to a destructive blowout, although with modern equipment and alert control such instances are rare. At the same time, in providing excess density as a factor of safety against blowouts and their dreaded menace of fire, one must not go too far, especially in porous formations, else excessive amounts of mud or water will be forced into the structure. Excessive mud penetration may seal an otherwise productive sand so deeply that production cannot be obtained.

During idle periods, as while running drill pipe to change the bit or when fishing for lost tools, cuttings should be held in suspension. This is accomplished by a colloidal dispersion which results in a weak gel when movement ceases, becoming fluid again upon agitation.

Mud seals the walls of the hole, decreasing the loss of fluid into porous structures, consolidating loose formations to prevent caving, and sealing off unimportant gas, oil, and water strata without cement. A colloidal dispersion which gels in the pores of the structures is desirable. The penetration of mud into a structure is small.

The movement of casing and drill pipe in the hole is greatly facilitated by a colloidal slime deposited on the walls. The action of protective colloids in coating abrasive material with slime also has lubricating value and decreases wear upon mud pumps and other equipment.

Circulating mud removes frictional heat from the bit and lower end of the drill pipe. Temperature, specific heat, and heat-transfer coefficients are important in this connection to the exclusion of other properties, but are satisfactorily taken care of without special consideration.

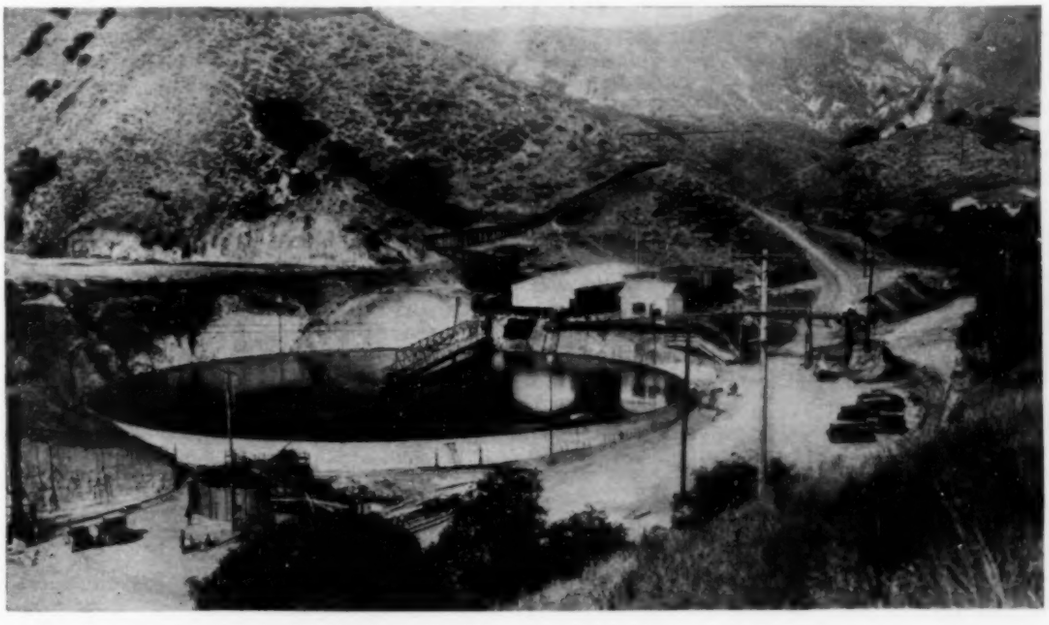
Important properties of rotary mud are density, viscosity and shearing strength, colloidal dispersion and graduation of particle size, and surface tension or interfacial tension against gas. They are interrelated under some conditions and independent under others, varying with geological structure and functions of the mud. Because of the innumerable combinations of conditions encountered, it is difficult to specify even ranges of desirable properties.

Density must be sufficient to make the hydrostatic head greater than gas or fluid pressure in the formation by a reasonable factor of safety but without forcing mud deeply into the structure. Under some conditions, the mud density may be little more than that of water. Under high-pressure conditions, as much as twice the density of water may be required to keep the well under control. The density depends in general upon the concentration and specific gravity of the solids present. Ordinarily, it is increased or decreased by adding clay or water as needed. Viscosity and dispersion must be considered simultaneously with density in most mud functions, the problem being to obtain adequate density, low viscosity as a rule, and a permanent suspension of solids. Combinations of these properties may be obtained, each being suited to the particular pressure, wall structure, and other geological conditions present.

Mud density generally is measured by weighing a given volume in a pail on a spring balance. Rusty and inaccurate balances are not unusual, however, and perhaps it was the astonishing weights obtained by a driller who used a fisherman's balance which led to more accurate methods, including a modified hydrometer and several types of continuous indicating or recording devices.

Viscosity is an indefinite term when applied to rotary mud of the gel-forming type. Such a suspension is really a plastic and its viscosity varies with characteristics depending on movement or elapsed time since movement ceased. As Bingham ("Fluidity and Plasticity," McGraw-Hill, 1922) has indicated, the viscosity and shearing strength of plastics may be determined with an efflux viscometer upon which pressure can be placed. The rate of flow through the capillary is plotted as a function of the differential pressure across it. The pressure intercept, which is the pressure required to start flow, is called yield point and is a measure of shearing strength. Yield point varies with the dimensions of the capillary used, while shearing strength is a property of the plastic. The pressure required to start flow in a pipe may be calculated from the shearing strength of the plastic and dimensions of the pipe. The method is described by Bingham. The point to be emphasized here is that the pressure drop accompanying flow through an orifice is the sum of the pressure required to produce fluidity and that required to produce flow.

A comparison of viscosities measured



Associated Oil Co. Plant After Completion Showing Flume From Mud Sump on the Hillside, Classifier Building, Thickener, Mud Storage Tanks, Belt Conveyor, Sand Dump, and Skimming Tanks

with an ordinary efflux viscometer upon materials of different yield point and shearing strength has little absolute significance. If care is taken to designate them as "apparent viscosity" under the particular conditions, they are useful in a general way in the field. For rapid measurements, the simple funnel described by Marsh is satisfactory for a comparison of efflux times, which may be combined with density to obtain apparent viscosity in centipoises.

Farnham (*Pet. Eng.*, February, 1931, p. 117) collected samples of mud which were judged satisfactory in field operations and determined their apparent viscosities with a Stormer viscometer (100 g-weight). He found 6 to 15 centipoises at 100 deg. F. representative of California practice. Shearing strengths were not stated. They probably were of the order of 0.1 to 1 lb. per sq.ft. for natural clay muds and 1 to 10 lb. per sq.ft. for bentonite mixtures. In some fields, as in Oklahoma, apparent viscosities lower than 5 centipoises are common. This means less than five times the viscosity of water at 68 deg. F. The upper limit recommended by Farnham is 30 centipoises.

It is a common error to confuse viscosity and density. A thick mud is not necessarily a heavy mud. Some muds which will scarcely flow have a density only slightly greater than that of water.

An important colloidal requirement is that a mud shall be fluid while in ordinary circulation but shall form a plastic gel when motion ceases, thereby preventing even massive particles from settling around the bit.

Surface tension and interfacial tension are important in connection with gas bubbles. Not enough is known as yet regarding them and their variations and effects upon gas cutting. Lester C. Uren (A.P.I. Prod. Bull. 207, 1931) has pointed out the need for rapid measurements of this kind at the well and for methods of control which will prevent gas adsorption or foaming.

The most generally useful method in use at present of comparing properties of one material with another is by plotting apparent viscosity as a function of density. For this purpose suspensions containing various proportions of the clay or mixture of solids are made, their apparent viscosities and densities measured, and a curve is drawn. A gel-forming colloid such as bentonite increases in viscosity rapidly with concentration. On the other hand, the apparent viscosity of other natural clays increases more slowly with concentration. It is possible, therefore, to obtain almost any combination of density and apparent viscosity by combining solids in various proportions. For careful control, curves of this type should be prepared in the laboratory by the use of the natural clays and proprietary colloids available. Curves of this kind, together with funnel-viscometer readings and simple settlings and gelling tests, are now generally used in the field.

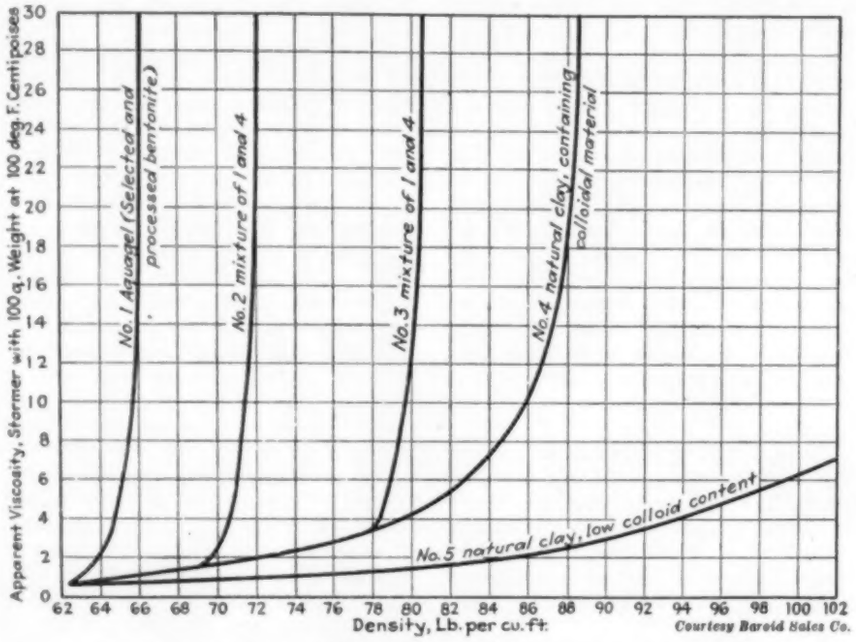
Sand and abrasives cause wear upon pump valves and liners, drill pipe, bits, and other equipment. If means for sand removal other than settling in flumes are not provided, it is not unusual for mud to be discarded after five or six days of use.

The presence of oil is objectionable because it tends to form viscous emulsions. It is a welcome sight to the driller, however, when it appears for the first time in the mud stream, indicating that oil sands have been encountered.

Gas is undesirable because it lowers the average density of the mud column. When it refuses to separate easily in the flume, the mud is said to be "gas-cut." The condition is thought to be colloidal, since the tendency increases with viscosity, and viscosity, for a given mud density, increases with the degree of dispersion. The driller's practice, when mud shows evidence of gas-cutting, is to jet the stream against a flat plate. Stirring, screening, and spraying have been tried with more or less success. Dilution followed by thickening, as practiced in one central reconditioning plant, is effective.

Processing includes the use of admixtures to control density and viscosity in various proportions, chemical reagents to increase or decrease the dispersion, and mechanical methods of removing sand, gas, and oil. If the required density cannot be obtained without excessive viscosity by adding clay, finely ground barite usually is added. Densities up to about 85 lb. per cu.ft. may be obtained with ordinary clay; with barite or other heavy inert material, densities of 100 to 105 lb. per cu.ft. are common. At a well where gas pressures are expected momentarily, a tank of heavy mud is held in readiness. The driller watches the level in the circulating tank or pit; when this rises, he knows that gas or liquid is entering the hole, whereupon he switches to heavy mud. Hematite also has been used in considerable quantities as a weighting agent.

Other inert materials are used to increase the dispersion and to act as protective colloids. Many natural clays contain gel-forming colloids in fair quantities, but the best control of density-viscosity relationships is not always obtained without mixing solids from two or more sources. By such mixing, almost any combination may be obtained. Selected bentonite is widely used to increase the colloid content and, therefore, the viscosity without proportionately increasing the density. When added to rotary mud, bentonite acts as a protective colloid, coating the larger particles and forming a permanent suspension. Sodium aluminate, one part to 600 parts of mud, also has been employed as a protective colloid (C. P. Parsons, *Oil Weekly*, June 20, 1930.)



Control of Density—Viscosity Relationships Can Be Obtained by Mixing Solids from Two or More Sources

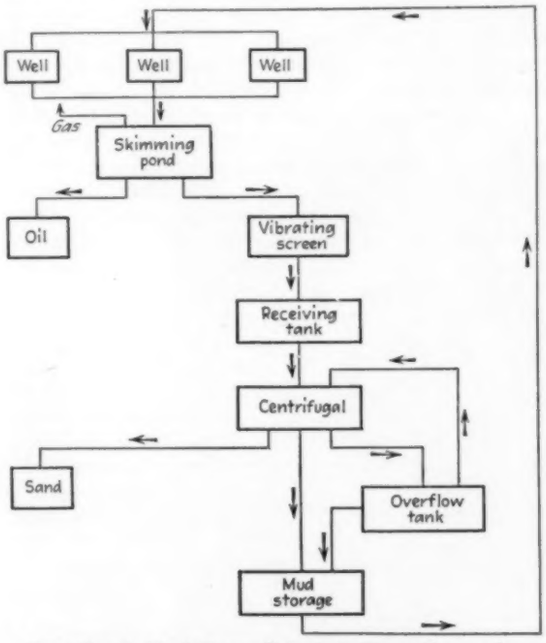
This is not a place to repeat well-known discussions of the electrical properties of colloids, the effect of varying concentrations of various ions, and adsorption in general. It is sufficient to say that the principles of colloid chemistry apply to rotary mud.

Numerous peptizing electrolytes have been tried with varying success. To find a universal mud-treating compound is, of course, as hopeless as to find a universal water-softening compound. Detailed analytical data regarding mud solids, water, and formations in the well are necessary to plan experiments intelligently.

Since dispersion and flocculation often are reversible, it should be possible to decrease the dispersion as the mud leaves the well, enabling it to drop sand and release gas, and then to peptize it and restore the desired dispersion. Several processes of this general type have been developed, but most of them are quite local in their application.

In some locations, particularly in the Gulf Coast states, shales are encountered which thicken the mud excessively with colloidal material. The problem here is one of decreasing the dispersion. Thinning with water is done at the expense of density and may result in a blowout. Treatment with sodium tannate has been described by Doherty, Gill, and Parsons (Prod. Bull. 207, A.P.I., 1931). Other flocculating reagents include caustic soda, either alone or with organic acids; sulphuric acid; hydrated lime; sodium silicate; and sodium sulphate.

The flocculating effect of sodium chloride is well known. To counteract it in wells which must, for economic reasons, be drilled with sea water, hydrated lime or caustic soda has been added until the pH value is 9 or more (Doherty, Gill, and Parsons, *loc. cit.*). Similar treatment is indicated when salt is encountered in the formation, although it is the usual practice when drilling through thick layers of almost pure salt to put the mud aside and circulate water only.



Centrifugal Mud Reconditioning Flow Sheet of Union Oil Co. of California at Venice

Mechanical processes include vibrating screens, dilution-classification-thickening, and centrifuging. Other ore-dressing methods probably will make their appearance. The type of equipment depends largely on whether a single well or a group of wells is involved. A few central plants have been built, but in locations where property is scattered in small parcels, individual installations are preferable. The trend of development is toward portable outfits for individual wells, and mud conditioning equipment may become a common adjunct of all drilling wells in the near future.

One successful type of vibrating screen consists of a 30-mesh screen mounted on four coil springs and vibrated by an electric motor. The stroke is about $\frac{1}{8}$ in., obtained without an eccentric arm by placing a small weight on one side of the shaft to unbalance the rotor. The screen receives the flow from the well at the head of the flume. Undersize material drops into the flume while the oversize is flushed away to waste. The combination of rapid shaking and short stroke produces satisfactory separation at low cost and with little attention. Tallant says a 4x5-ft. 30-mesh screen at an angle of 15 to 28 deg. will handle up to 700 or 800 bbl. per hour, which is ample for California drilling. The installed cost, he says, is $1,000 to $1,500. Monel metal screens cost $40 and last about 42 days, making a replacement cost of about $1 per day. The useful life of mud has been increased more than ten times by continuous screening. While fine sand is not removed, such particles seem to be sufficiently coated with colloidal material to render them much less abrasive.

Wilfley tables and other ore-dressing equipment are being used experimentally and various combinations or riffles and baffles in the settling flumes also have been introduced.

The most elaborate mud-conditioning plant to date is that of the Associated Oil Co. at Ventura, Calif. It originated with a waste-disposal problem. The location is mountainous, and all the available canyons had been dammed and filled with discarded mud. New mud was available at practically no cost from hillside clay deposits on the property; therefore reconditioning became attractive only when the operators were faced with the cost of trucking away sand-laden mud.

In the bottom of a canyon the plant has been located. Used mud gravitates to it in flumes from wells on the hillsides. The mud is collected in a 1,000-bbl. tank, from which it flows to a small distributing tank feeding four Dorr bowl classifiers. Diluting water is added in the distributing tank and classifiers. Gas escapes to the air. The sand discharged by the classifiers is carried in belt conveyors to a waste dump, while the thin slime gravitates to a traction thickener. The underflow from the thickener is reconditioned mud; the overflow, water and oil. Mud is stored in two 2,500-bbl. tanks, from which it is pumped back to the wells as required. Oil is skimmed from the water in a skimming tank and the water is recycled.

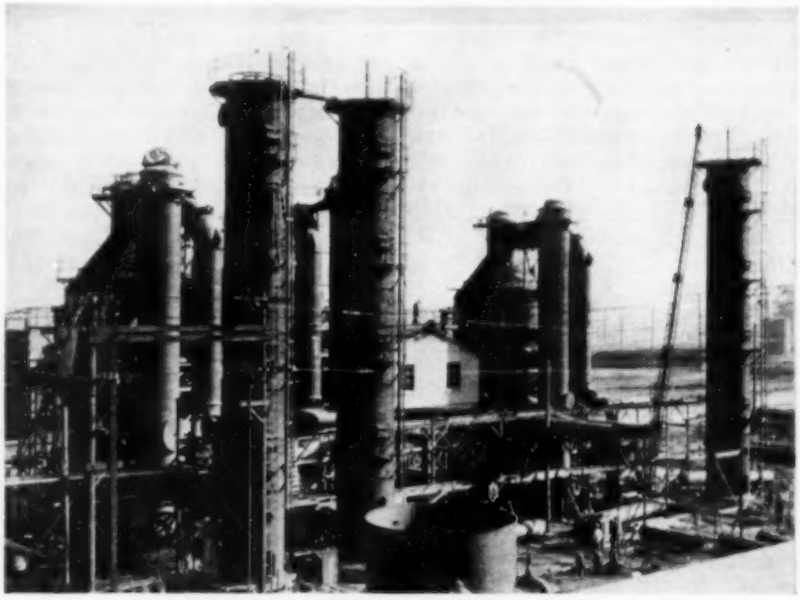
The process is effective for sand removal, turning out a fluid lower in sand content than freshly mixed hillside mud. It requires little water makeup. The maximum capacity is about 10,000 bbl. per day of 76-lb. fluid, or sufficient to provide 20 wells with a daily change. The cost of treatment varies between 5 and 12 cents per bbl., according to Tallant. A plant of this magnitude could be duplicated in few places because the development program is seldom so well adapted to a central plant. Moreover, the general process is dependent upon the geological structure for most of the colloidal material in the mud. It is apparent from theoretical considerations that gravity sedimentation cannot increase the concentration of the desirable colloidal matter to what it was before dilution, and such a process, while effective for removing sand, gas, and oil, may accomplish these results at the expense of colloid content. Colloidal material is dispersed on dilution and continues to circulate with the water in the process until it reaches a concentration where some flocculation or coagulation occurs. In this particular location, colloid makeup is obtained from the formation. Where this is not possible, dilution and gravity sedimentation processes may require additional treatment such as flocculation, coagulation, and filtration if colloidal particles are to be returned to the thickened mud.

Centrifugal separation has been applied by the Union Oil Co. of California in central plants at Venice and Santa Fe Springs, Calif. Used mud, after passing through a vibrating screen to remove foreign matter and large particles, passes into a receiving tank. If the mud is contaminated with oil, it first passes through a skimming pond. Separation is effected in a Merco centrifugal rated at 600 g.p.m., sufficient to provide seventeen wells with a daily change. The throughput depends on the separation required, the sharpness decreasing with increasing rates. Sand removal is nearly complete and without loss of colloidal fines. The total investment, including pipe lines, is about $12,000. Based on rates far below capacity, Tallant gives an operating cost exclusive of fixed charges of 16 cents per barrel of mud.

In a general summary article on a subject already well discussed, it is almost impossible to avoid inadvertent quotations; therefore indulgence is begged in the case of acknowledgments unintentionally omitted. Particular indebtedness is acknowledged to Hallan N. Marsh and Gerald Fisher, of the General Petroleum Corp. of California, for assistance.

Why Shell Built Its Ammonia Plant in California

By LUDWIG ROSENSTEIN
Shell Chemical Co.
Shell Point, Calif.



Benzol Absorption Plant at Shell Point, Calif.

AMMONIA synthesis by the low-pressure Mont Cenis process, as recently described by W. F. Scholvien (*Chem. & Met.*, Vol. 38, 1931, p. 82), has been developed to a point where its production cost of ammonia compares favorably with that of high-pressure processes. In any ammonia synthesis the efficiency and life of the catalyst is the point of prime importance, and largely because of the sturdy qualities of the Mont Cenis catalyst the Shell Chemical Co. chose this process for installation in its new plant at Shell Point, Calif.

The production of fixed-nitrogen products, like almost every chemical industry, is today in a stage of overproduction as far as immediate market demands are concerned, which means merely that a broader viewpoint than that of immediate markets must be taken. Fixed-nitrogen products are essential to modern food production, and it must be recognized that the term overproduction of foodstuffs contains fallacious economic doctrine. Never yet in the history of the world has the production of foodstuffs over extensive regions been so great that all have been adequately fed. Today we see the depreciation of great stores of foodstuffs in granaries and warehouses, while simultaneously and in adjacent regions human beings are on short rations or actually hungry. While it is true that production of food, and of fixed nitrogen—or, rather, potential production in the shape of installed capacity, whether farm land or manufacturing plant—has outrun the immediate consumption, it is equally true that an equilibrium in this business between production, price, and consumption will again be established, and that producers not within the submarginal fringe will again be able to carry on profitable operation.

In our corn belt we have machinery which enables one man to plow daily about 320 acres, to plow deeper, and to cultivate more thoroughly than ever before. The problem then is, how much will be added to the productivity of this man, his machine, and his land by the addition of manufactured fertilizer? Without attempting any deep analysis it may be simply stated that the belief of those who have embarked on this enterprise is that the continuation of mechanization of agriculture, accompanied as this must be with rising agricultural wages, will in the future result in a far more extensive use of fertilizers than is at present practiced.

The fertilizer consumption per acre per year in pounds of plant food ingredients (calculated from figures given for the year 1928 by U. S. Department of Agriculture Circular No. 129 and the International Yearbook Agricultural Statistics, 1928-1929) are as follows: Holland, 367; Germany, 72; Japan, 56; France, 35; Italy, 21; and the United States, 8. It is evident that those countries whose agricultural land is most limited use the largest quantity of fertilizer. That United States soils will be worked more intensively as our population increases can hardly be doubted; and our fertilizer practice will then approach that of the older communities.

The entry of the Shell group into the fertilizer business is not so altogether new; it has been interested in a Mont Cenis plant operated since 1929 by the Mekog Co. at Ymuiden, Holland. The addition of the Pacific Coast unit is, in a sense, another step in a broad plan to establish nitrogen plants at those points most favorable for raw-material supply. The California population is growing rapidly, while arable land is strictly limited, the limitation being the water which can be made available to agriculture. These conditions must bring about increasing intensity of cultivation, and therefore an increasing demand for manufactured fertilizer. The choice of the Pacific Coast is further based on the fact that extensive areas in California, Hawaii, and the Philippines which are already educated to an intensive use of nitrogen fertilizers can be economically served; and, furthermore, large quantities of gases are available for the production of hydrogen. In fact, it is the occurrence of large and otherwise useless quantities of gases in parts of the world in which the Shell group has interests which was largely instrumental in turning attention to hydrogen production and synthetic ammonia. I mention the two separately because hydrogen production is not without distinct interest of its own.

The plant at Shell Point receives, in addition to air, natural gas consisting of about 85 per cent methane, 12 per cent ethane, and 3 per cent higher hydrocarbons. It is free of sulphur compounds and inert gases. From this raw material hydrogen and carbon are produced by a cyclic thermal decomposition, wherein a brick checker work is heated by gas flames to about 1,100 deg. C. and natural gas then passed through till the temperature sinks to about 900 deg. C. The re-formed gas

is scrubbed with water for the removal of tar and carbon in equipment well known in the gas industry. The gas contains about 70 per cent hydrogen, 5 per cent carbon monoxide, 0.5 per cent carbon dioxide, small quantities of acetylene, ethylene, naphthalene, and benzol; and a substantial quantity of undecomposed methane.

Purification of this gas is a matter of considerable complexity and equipment for accomplishing it is a large proportion of the total equipment in the plant. Naphthalene and tar are removed by oil scrubbers, carbon dioxide and benzol by water and oil scrubbing at high pressure, followed by caustic soda scrubbing to remove the last traces of carbon dioxide. The gas, after the last operation, is ready to go to a Linde gas-fractionation plant where pure hydrogen is produced by condensing everything else. Carbon monoxide is scrubbed out with liquid nitrogen, and acetylene with liquid ethylene. The final product contains hydrogen and nitrogen only. On the absence of even minute traces of impurities depends the success of the subsequent operation of bringing about the combination of the two constituents to form ammonia.

Nitrogen is produced by rectification of air in a Linde plant. Oxygen is at present discarded, but probably will find a use in the future as a chemical raw material.

The synthesis is carried out at about 400 deg. C. and at a pressure of about 100 atmospheres. The exit gas from the synthesis bomb carries about 12 per cent ammonia, while the returned gas contains about 1½ per cent. The description given by Sholvien of the details of operation of the synthesis part of the system is so complete that repetition here would be superfluous. The method and apparatus used for removing the ammonia produced from the gas mixture and for returning the remaining mixture to the synthesis system, however, is fundamentally different from that in use in the other Mont Cenis plants. A patent on this part of the system has been allowed and will be issued presently. At the present time the ammonia produced leaves the plant either as ammonium sulphate, as liquid ammonia, or as aqua ammonia.

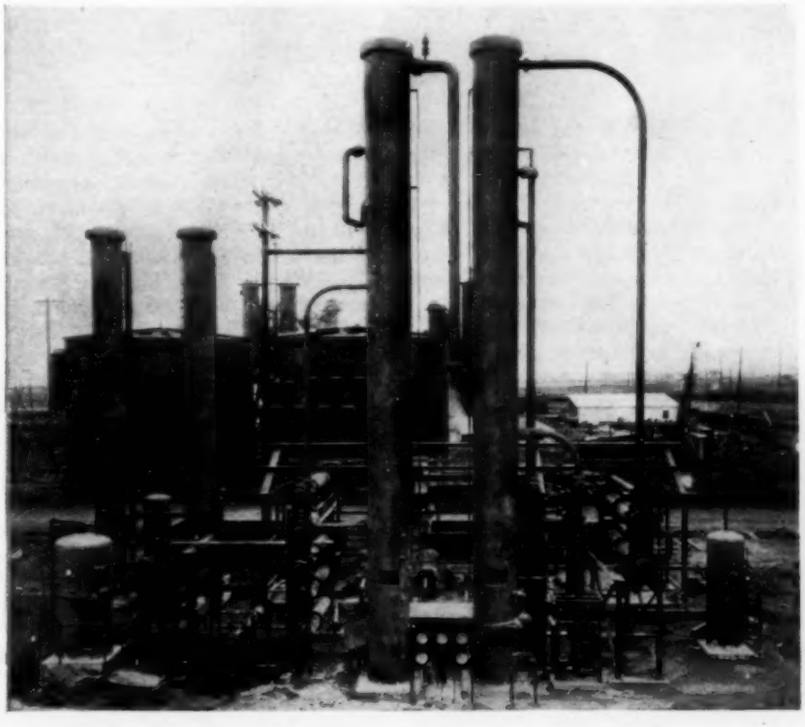
The production of ammonium sulphate from pure ammonia is by no means a simple matter. Where this is done by neutralization with sulphuric acid the heat evolved is very considerable and its removal must be provided for. This is accomplished by so arranging the saturators that a quantity of water corresponding to the heat of neutralization will be evaporated. Furthermore, the crystal form of the product varies greatly with the quality of the sulphuric acid and depends also on the mode of neutralization.

Under some circumstances clusters of needle-like crystals are produced which dry poorly and pack badly even after complete drying. Under other conditions crystal granules with excellent drying properties are produced; and, of course, the aim is to maintain the latter conditions, a problem by no means simple, as the factors which influence crystal habit are not all known. Ammonium sulphate crystals are separated from mother liquor by a continuous filter and are then dried in a steam-heated continuous rotary dryer.

Liquid ammonia is produced by refrigeration of the gases coming from the catalyst chamber. That portion which is evaporated and made into sulphate obtains its heat of evaporation from the gases issuing from the catalyst chamber. About one-third of the production is sold as liquid for nitric-acid manufacture, while two-thirds is made into sulphate.

The plant as it stands consists of two units having each a capacity of 30 tons fixed nitrogen daily. Besides liquid ammonia, aqua ammonia, and ammonium sulphate each unit produces about 100 gal. of very pure sulphur-free benzol, about seven tons of a very pure carbon, and a small quantity of naphthalene.

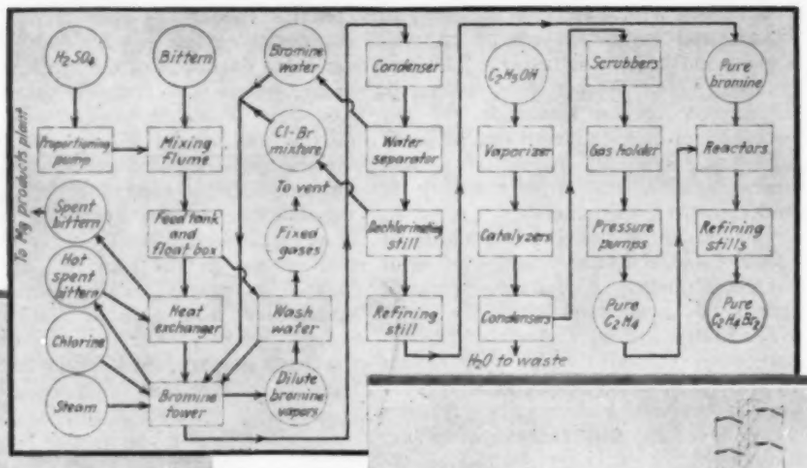
The location of the plant within 30 miles of San Francisco Bay was chosen only after careful consideration of many other sites both in the northern and southern part of the state. The region of which Shell Point, Calif., is about the center is well supplied with chemical plants, and consequently with a supply of workmen and operators more or less familiar with the machines and processes involved in chemical operations. Three railroads, as well as water transport, serve this region. The supply of water for cooling and other purposes is ample; abundant natural gas is delivered by two pipe lines; and last, but not least in importance, the climate makes outdoor operation all the year round easy and agreeable.

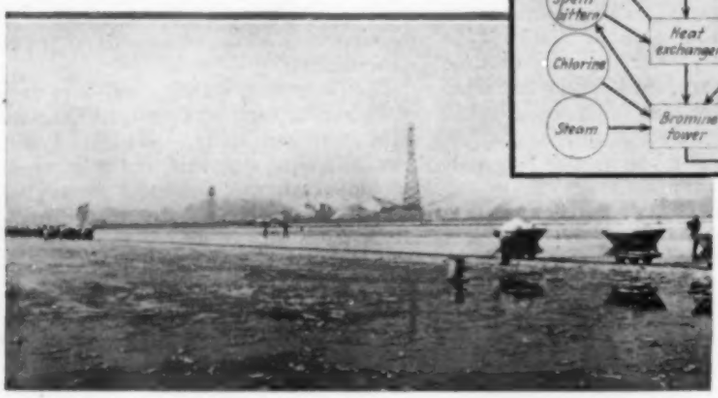


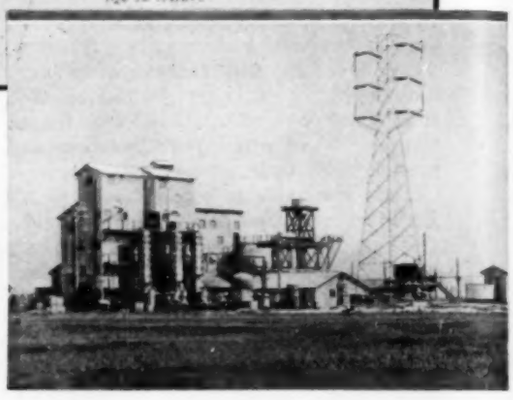
Natural Gas Is Cracked to Form Hydrogen for Ammonia. This Is the Only Plant of Its Kind in the United States

Right: Flow Sheet of Bromine-Dibromide Production in the Plants of the California Chemical Corp.

Below: From Crystallizing Ponds Such as This, Used by the Arden Salt Co. for Solar Salt Production, the Mother Liquor or Sea Water Bittern Is Drawn for the Extraction of Bromine and Magnesium Values.







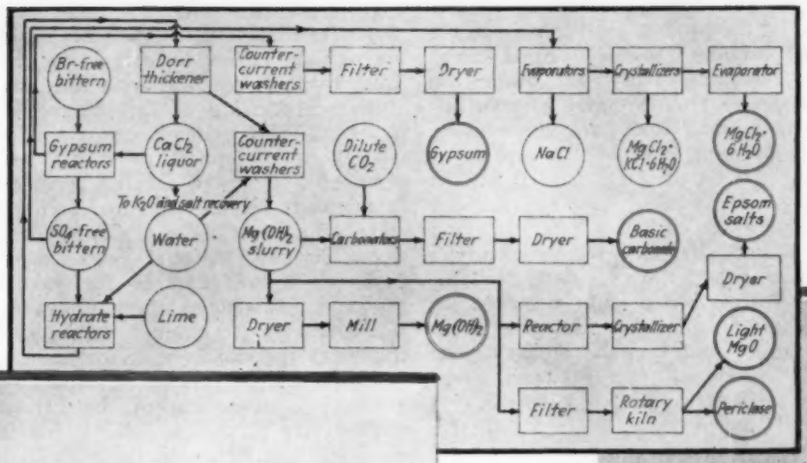
Bromine and Magnesium from Western Bays and

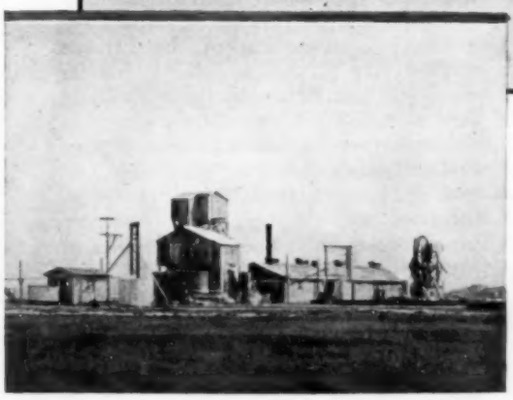
ONE of the healthy youngsters in the growing chemical industry of the Pacific Coast is the California Chemical Corp., a member of the Sierra Magnesite Co., Ltd., group. This organization is particularly notable in being built entirely on a background of raw materials peculiar to the West Coast. Thus, although a controlling interest in its ownership is now held by United Chemicals, it is in no sense a branch of an eastern operation, as its materials, processes and products, taken as a whole, are with but rare exception not duplicated east of the Rockies.

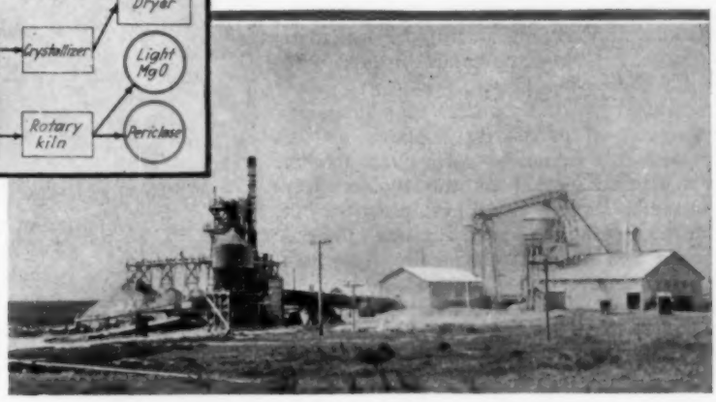
In examining the establishment and expansion of a closely related group of industries the connection between cause and effect is sometimes difficult to trace. In this case, it may not be immediately apparent why the low quality of plastic calcined magnesite from foreign sources after the War should logically have resulted in the genesis of the second largest bromine producer in this country. Yet the steps are plain enough. In 1920, poor magnesite quality forced the largest consumer of this commodity (the National Kellastone Co.) into acquiring its own plants and properties in California, with the resulting incorporation of the Sierra Magnesite Co. In 1923, demand for an accessory raw material (magnesium chloride) became so acute in the West as to warrant the establishment of another organization—the California Chemical Corp.—to supply this product. This latter concern has gradually expanded its operations to recover first bromine and then other values from sea water bittern, its basic raw material. As a result its activities have surpassed those of its parent and of its sister industry, and accordingly, will be first discussed, and in greater detail.

Practically all of the common salt consumed on or shipped from the Pacific Coast is produced by the solar evaporation of sea water. A solar salt operation requires for its success the combination of availability of a large acreage of land of moderate value, adjacent to the ocean or an ocean bay and of low and essentially constant level, a climate showing high yearly evaporation and low rainfall, a soil of almost zero permeability, and a location reasonably adjacent to principal markets. The required happy combination is found in only two localities in the West, both in California, and hence salt production is primarily centered on the southeast border of San Francisco Bay, with a smaller operation near the southern tip of San Diego Bay and one on the west shore of San Francisco Bay. Solar salt production, formerly attempted by a host of small operators, has now chiefly passed into the hands of three concerns, which supply Pacific Coast and export markets with all of the commercial grades of salt. In years past, although spasmodic efforts had been made to recover other values than salt from these operations, the sea water bittern in which such values are concentrated had normally been thrown away. It is this sea water bittern on which the processes of the California Chemical Corp. are based, its supplies being obtained, through long-term contracts, from the three principal western salt producers. The view at the left above shows crystallizing ponds operated by one of these producers.

In solar salt production, sea water, introduced through tide gates into immense shallow earthen ponds is gradually brought to saturation with salt through long exposure to the weather. As concentration proceeds, the brine is forwarded from pond to pond, finally being pumped to earth-bottomed "crystallizers" in which further evaporation deposits the greater part of the salt as coarse crystals. When crystallization







Left: Flow Sheet of Magnesia Products Recovery, as Practiced by the California Chemical Corp.

Below: This Lime Plant at the Newark Works Yields an Oyster-Shell Lime of Exceptional Qualities

Center: General View of Bromine and Magnesia Products Plants at Newark, Calif.

Compounds Drawn From Hills

By MAX Y. SEATON

California Chemical Corp., Newark, Calif.

has proceeded to the point where the gravity of the mother liquor reaches 27 to 31 deg. Bé.—the exact value depending on the operating practice of the salt producer—the liquor is drawn off, and the residual salt, usually after one washing in place, is removed wholly or partly by hand from the pond bottom. Then it is sent to the further washing, drying, sizing, and refining processes which fit it for the market. It is this once-waste mother liquor, or sea water bittern, which now serves as raw material for another industry. Depending on individual operating conditions and on bittern strength, the bittern yield per ton on salt produced varies from 200 to 400 gal. Analyses of typical bitterns are shown in the tabulation on the following page.

Although the California Chemical Corp. has unit plants located at Chula Vista, on San Diego Bay, and at San Mateo, on the west shore of San Francisco Bay, its major activities are centered at Newark, in the heart of the salt production area of the east shore of San Francisco Bay. This locality has much more to recommend it than mere availability of a raw material. It has main-line transportation facilities and, shortly, deep water dockage will be available at its very door. A mild climate, making plant heating essentially unnecessary at any time, permits the use of economical buildings and avoids the need for protecting the plant pipe lines from freezing. Thanks to Horace Greeley, labor of unusual intelligence is abundantly available even in normal times. Excellent fresh water occurs in shallow gravels, while unlimited salt water is available for cooling. The plant is only a short distance from the principal natural-gas line entering San Francisco, and as a result natural gas, costing even less than the cheap fuel oil available in the West, is used as a primary fuel. A high-voltage transmission line passes through the plant property. Besides bittern, an exceedingly pure and cheap source of lime is available as raw material. These features give some indication of the sound economic background which the operation possesses.

Bittern from the several salt producers is delivered from their crystallizers into bittern ponds at five different locations near Newark, all within a radius of some 5 miles (San Mateo and Chula Vista have a single delivery point each, immediately adjacent to the bittern processing plant). These delivery ponds have only a limited capacity. They do serve, however, for retention of fresh bittern over a reasonable period, during which time solar evaporation further concentrates any low-gravity material to the higher of the two concentrations shown in the tabulation. During this further evaporation an impure salt is deposited and is ordinarily washed from the delivery ponds by the winter rains. If recovery of common salt from bittern is desired, retention of bittern in delivery ponds is avoided.

Delivery ponds are connected to the Newark plant by pipe lines, bittern being forwarded by immersed centrifugal pumps, so equipped that they are automatically and periodically washed with fresh water to remove salt incrustations. Bittern is delivered into some 50 acres of primary and 30 acres of secondary storage ponds. These ponds are prepared by throwing up an earth dike on impervious clay land, the dike itself having a clay core keyed into the impervious strata. Large storage facilities are essential, as bittern deliveries from the salt producers are received only during summer and fall months, and must be stored through winter and spring. The primary storage ponds have an effective capacity, when filled to a 6-ft. depth, of approximately

Composition of Typical Pacific Coast Sea Water Bittern

	Bittern			
	Gravity 28 deg. Bé.,		Gravity, 30 deg. Bé.,	
	Per Cent	Tons per 10^6 Gal.	Per Cent	Tons per 10^6 Gal.
NaCl	16.0	823	12.5	656
MgCl	6.0	309	8.7	457
$MgSO_4$	4.2	216	6.1	320
KCl	1.4	72	1.9	100
Br	0.121	6.2	0.175	9.2

115,000,000 gal. Surprisingly little dilution by winter rains is observed. Rain water floats on top of the heavy bittern and evaporates off during fair weather without having appreciably mixed with the underlying liquor.

Recovery of bromine from bittern is carried on at all three plants of the California Chemical Corp. The process is a modification of the Kubierschky system, largely used in Germany, but altered to fit the particular raw material used and to employ typically American equipment. A flow sheet of the process employed at the Newark plant, which shows also the steps involved in the preparation of ethylene dibromide, appears on the second page preceding. It can be briefly described as follows: Raw bittern has a slight and variable alkalinity, which makes its further processing difficult. Accordingly, from the storage ponds it is pumped to a large surge tank, from which it issues as a controlled stream into which the necessary quantity of concentrated sulphuric acid to give essential neutrality is introduced by a proportioning pump. The flow then passes to concrete reservoirs which hold several days' plant supply. From these reservoirs the neutral bittern is pumped to an elevated supply tank. It next flows, by way of a constant-level float box which insures absolute regularity of feed, to the bromine separation towers, being warmed in transit by passage through a heat exchanger, countercurrent to exit tower liquor.

The bromine towers are square hollow towers, built of granite or soapstone plates and filled with a ceramicware packing designed to give intimate contact between gas and liquor. Bittern is introduced at the top, steam at the bottom, chlorine gas at an intermediate point. When the proportions of these three materials are in proper balance a hot, practically bromine-free liquor escapes at the bottom, while bromine vapor, plus a little chlorine and some water vapor, is expelled through an opening near the top of the tower. This vapor mixture goes to a stoneware condenser, the condensed water is separated by gravity from the crude liquid bromine, and this latter has its chlorine content removed and returned to the tower system by distillation in a continuous lead-and-stoneware still. The chlorine-free bromine is further purified from traces of organic matter in a continuous distillation system, and is then ready for marketing as purified bromine or for conversion into bromine compounds. All bromine-containing vapors and liquors appearing at any stage of the process are returned to the main bromine towers. Final fixed gases escaping from the tower are washed free from bromine by cold bittern in a small stoneware wash tower. Three bromine towers, each capable of taking a feed of 2,000 gal. of bittern hourly, are installed at Newark, with a single tower each at Chula Vista and San Mateo. Bromine recoveries of 95 per cent or better are regularly realized.

All three plants are equipped to manufacture ethylene dibromide from the pure liquid bromine which is the initial product. To this end, pure ethylene gas is prepared by dehydrating alcohol by passage over a suitable catalyst, the water being condensed out and the gas being purified by chemical scrubbing to a product containing negligible traces of impurities. The purified ethylene is then contacted with pure bromine at low pressure in a glass-and-stoneware system, reaction between the two components being ready and complete. The ethylene dibromide resulting requires further treatment for removal of reaction by-products, and is then ready for marketing, being shipped in steel drums or tank cars. The Newark plant is being equipped to manufacture the usual inorganic bromides.

Exit liquor from the bromine recovery towers has essentially the same composition as the raw bittern with the exception that its small bromine content has been replaced with chlorine. Some 3 per cent dilution by condensed steam also has occurred. Both Newark and Chula Vista plants process this liquor for magnesium chloride recovery. This step involves the concentration of the bittern in multiple-effect, salt-type vacuum evaporators. Sodium chloride separates hot, while cooling of the evaporated liquor (in batch coolers at Chula Vista; continuous coolers at Newark) gives an essentially pure, saturated solution of magnesium chloride, which is separated from magnesium sulphate, potash, and residual sodium salts by settling and centrifuging. The magnesium chloride solution is further evaporated in open pans until it has the composition $MgCl_2 \cdot 6H_2O$, and this hot liquid is chilled to give solid, flake or powdered commercial magnesium chloride.

Other Salts Now Recovered

The present magnesium chloride market which can logically be served from a Pacific Coast plant will absorb but a fraction of the total magnesium values present in the bittern now being received, which quantity is regularly increasing as salt consumption of the West Coast steadily grows. Accordingly, after extensive laboratory investigation and some two years' pilot operation, a small plant for recovery of these values in other forms is now in production and a large plant is being engineered. Basically, the method employed is that of conversion of soluble magnesium values to magnesium hydrate through reaction with lime, and further processing of this magnesium hydrate. This scheme can claim no novelty in conception, as it has been repeatedly suggested for the treatment of Stassfurt residues and for Michigan and Ohio River brines. Particularly favorable raw material costs, recent development of markets for certain products, and some substantial advances in operating technique make such treatment feasible as a major addition to the present Newark plant. Space for a complete discussion of the various steps of the process is lacking, but its essentials are shown in the right-hand flow sheet on the preceding page.

Fundamentally, aside from the general economic features of cheap raw and operating materials and favorable location, the magnesia-value recovery process rests on the developed ability to prepare a precipitated magnesium hydrate which settles and washes rapidly and can be filtered readily. Settling rates of several feet per hour, filter cakes on a rotary vacuum filter 2 in. thick, and filter-cake water content of only slightly over 50 per cent represent values believed to be unique in the handling of magnesium hydrate, ordinarily considered as a slimy, slow-settling precipitate filterable only on a leaf filter, if at all. Development of the desired properties has been in part due to an elaborate study of process conditions, but in even greater measure to the recognition of the fact that the properties of the product are dependent to a considerable extent on certain characteristics of the lime employed and on the finding of methods for obtaining these characteristics.

No detailed review of the products shown on the last-mentioned flow sheet is possible at this time. Magnesium basic carbonate is a well-known product, with established markets, some of which, however, are still susceptible to a considerable expansion. Magnesium oxide, produced by the calcining of magnesium hydrate, occupies an intermediate ground between commercial plastic calcined magnesite and technical light magnesium oxide, and because of its excessive fineness, high purity, and low cost, finds a field which neither of the former products has been able to reach. Technical powdered magnesium hydrate, also a product not previously available, has been found of interest as a neutralizing medium because of its high reactivity and formation of soluble reaction products. It is substantially less costly than caustic soda and lacks the disadvantages of lime. The by-product gypsum from the process, through operation of favorable location factors, is marketable at a profit instead of being a valueless waste.

These highlights must serve as comments on the magnesia division prod-

ucts, as there remains much ground to cover. Before discussing the next operation, however, it should be mentioned that no large-scale recovery of either the salt or the potash content of the bittern has yet been undertaken. Although the potash tonnage in the bittern processed is not large, it is nevertheless a substantial item. Pilot operation has indicated the feasibility of its recovery from the wastes or the recirculated load of the magnesia plant, and with the operation of this major plant in 1932, potash manufacture will become practicable. It is also obvious that the sodium chloride tonnage possible of cheap recovery is very large.

Special Lime Is Requisite

The vital necessity of cheap lime of special characteristics for the magnesia products plant has been mentioned above. Years ago San Francisco Bay abounded in beds of small Pacific Coast oysters, and although live oysters have largely vanished from the bay, their débris, in the form of immense beds of oyster shell, remains. For years much of the portland cement made in the San Francisco district has used this oyster shell as a lime source. By the application of suitable dredging and washing methods, oyster shell can be obtained as an almost pure calcium carbonate, containing only less than 1 per cent of magnesium carbonate, under 0.1 per cent silica, and traces of iron, aluminum, and manganese oxides.

Work on the processing of oyster shell to a chemical lime of unique characteristics was started some three years ago, and culminated in 1930 with the construction of a commercial lime plant with a capacity of about 12,000 tons yearly. Shell dredged from suitable banks in the lower bay is thoroughly and repeatedly washed on the dredge, barged to plant, and burned in a rotary kiln, which is followed by rotary cooler, storage bins, continuous hydrator, mill, etc. Lime plants are an old story to the chemical industry, and no elaborate description of this one will be attempted. In one respect, however, it is unique. In spite of the fact that it is regularly producing lime for normal markets, it is pointed primarily toward the preparation of a material of unusual properties for the magnesia-products plant. A finding of many years' standing in the operations of the Sierra Magnesite Co.—namely, that the reaction properties of its commercial magnesium oxides were dependent on degree of molecular aggregation, which in turn is a function of processing time-temperature—proved to be transferable to solution of the problem of lime-quality control. (Numerous patent applications in this field are pending.)

To develop the desired characteristics in oyster-shell lime, however, required the application of temperatures as high as 1,600 deg. C. No normal or even high-alumina firebrick will withstand such a temperature under the conditions which exist in a rotary lime kiln. Fortunately, the art of manufacture of refractory brick from relatively pure crystalline magnesium oxide (artificial periclase), which for several years an associated organization has produced, had advanced to the point of allowing the use of a periclase refractory to be considered. In a periclase-lined rotary kiln, any temperatures attainable by combustion of fuel, even with preheated air, can be employed without the slightest lining attack. Oyster-shell lime, burned at these abnormally high temperatures, is not only uniquely valuable for the magnesia-products plant but is a chemical lime which is exceptionally pure and possesses an extremely high reaction and settling rate. It is accordingly being offered to Pacific Coast markets both as quick and as hydrated lime. Incidentally, it should be mentioned here that for the attainment of these high temperatures in a rotary kiln, natural gas has proved a dismal failure.

Operations of the Sierra Magnesite Co., Ltd., must be passed in rather hasty review. All of the active magnesite producers of the United States are found on the Pacific Coast. All of the caustic calcined magnesite made in this country is produced in California. Two operators have long dominated this latter field, one of which is the Sierra Magnesite Co. In the heyday of the oxychloride industry, a far greater tonnage of calcined magnesite was consumed than at present. With the shrinkage of oxychloride outlets, other consuming fields have been sought. The most important of these is found in the use of artificial periclase as a refractory. Although periclase has long been recognized as a constituent of normal dead-burned magnesite, it was believed that the production of a high-purity product, because of absence of fluxes, involved temperatures beyond the range of a fuel-fired furnace. A moderate quantity of periclase was made by electric-arc-furnace fusion, but costs were so high that the use of the material was quite limited.

Some five years ago, through a combination of improved combustion technique as applied to a rotary kiln, and use of a periclase refractory lining, a high-purity artificial periclase was first produced in the Porterville (Calif.) plant of the Sierra Magnesite Co. In the intervening period both plant and refractory production practice has been improved to the point where high-purity periclase is now available at low cost. The refractories produced from this material, which have properties of high load resistance and freedom from spalling formerly believed impossible of attainment in a magnesium oxide brick, are now being regularly offered by several refractory manufacturers at prices equivalent to those demanded for normal magnesite brick.

Development of this product has necessitated an expansion of manufacturing facilities on the part of the Sierra Magnesite Co. Its Porterville plant and mines were judged inadequate to cope with the growing demand for material of extremely high purity. Development work on a new magnesite property near Gustine, Calif., had been under way for some time, and with the defining of a large tonnage of extremely high purity ore there, construction of a fully modern manufacturing plant was undertaken in the summer of 1931, operation being scheduled for late fall. This plant, located at the Bald Eagle Mine, is approximately 16 miles from railroad in the hills which form the western boundary of the upper San Joaquin Valley. Magnesite (natural magnesium carbonate) occurs as a blanket 4 to 12 ft. thick in decomposed serpentine. Aside from approximately 2 per cent calcium carbonate, impurities are confined to very small quantities of the oxides of silicon, iron, and aluminum. Some waste material high in impurities is unavoidably introduced in mining, but, fortunately, these impurities differ radically in hardness from the ore proper. Accordingly, mine-run ore is crushed, screened on multiple deck screens, oversize recrushed and rescreened. Impurities migrate toward the fines. Calcining of properly blended material is accomplished in a 100x6-ft. rotary kiln, lined with special periclase refractories, and fired with oil. Both caustic-calcined and dead-burned magnesite, as well as artificial periclase, will be made in the Bald Eagle plant. Products will be transported by truck to a loading and grinding plant on the Southern Pacific R.R. at Ingomar, Calif. Capacity of the new operation is to be 12,000 to 15,000 tons yearly, with definite provisions for doubling or trebling output. After it is functioning smoothly, operation of the Porterville plant will be discontinued.

Magnesia Sources Interchangeable

It is of interest to note that the magnesia products plant at Newark, using bittern and lime as raw materials, can and has duplicated the products of the Porterville and Bald Eagle operations, which use magnesite as raw material. Conversely, magnesite may, in selected cases, serve as raw material for products normally produced at Newark from lime and bittern. The advantages of this interchangeability, in following changing raw material and market situations, is obvious. It makes further apparent the logic behind the consolidation of two industries which on the surface are but little connected but which it finally appears are uniquely interrelated. Working on typically western raw materials under typically western conditions, these operations add color to the rapidly developing chemical picture on the Coast.

Limitless Power Resources Presage Western Industrial Trend

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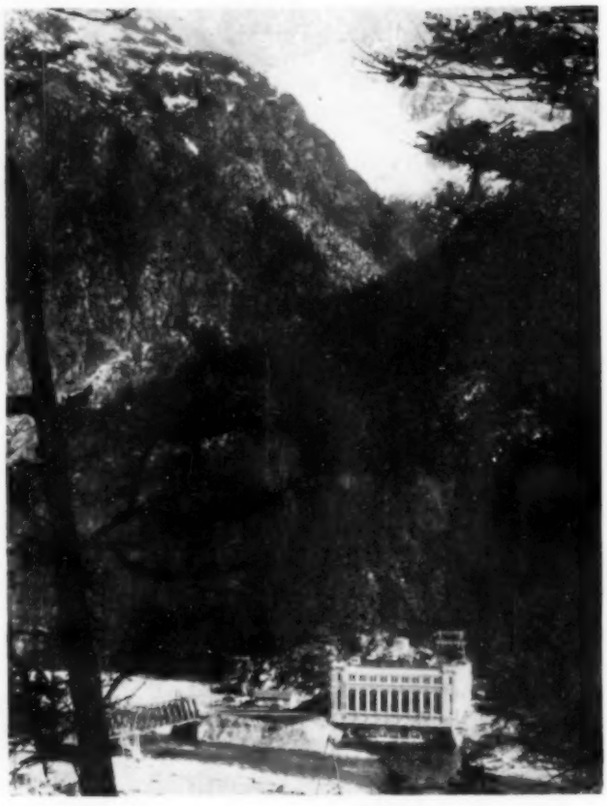


Gorge Power House, Skagit River Wash.; Present Capacity, 75,000 Hp.; Ultimate Capacity, 320,000 Hp.

DEVELOPMENT of the process industries of the Pacific Coast, as in other sections of the world, has been intimately connected with the development of the power resources of the region. And it is a unique combination of climate and power resources which will, we venture to predict, bring to the Coast a concentration of population and a variety of process industries hardly dreamed of today, a development greater than those that have grown up around the hydro-electric power plants of Niagara and Norway, or around the coal fields of Pennsylvania and Wales. Along the Coast for a distance of nearly 3,000 miles, from San Diego Bay to the Gulf of Alaska, there is a "year-around climate" in which the worker and the factory manager need never worry about extremes of cold or of heat. In this region there is a concentration of power resources like nothing elsewhere in the world—a region furnishing almost unlimited supplies of coal, oil, gas, wood, and flowing water.

In the nineties, when the senior writer moved to the Coast from the coal-burning East, the use of petroleum fuel was just being started in an experimental way in southern California industries. At that time, all along the Coast the main reliance for fuel was placed on the low-grade local coals and on wood, supplemented by high-grade coal imported at great expense from the East, Canada, and Australia. At that time, the industries were few and very small. Process manufacturing was mainly confined to the San Francisco Bay region, where John Stauffer was making cream of tartar, sulphuric acid, and refined sulphur. Explosives for the mines were made in a small way. A pioneer soul, near Portland, Ore., working ten years ahead of his time, was making a true portland cement, using a gas-fired rotary kiln. These and other process industries operated in a small way to supply a very limited local market. Costs were far too high—mainly on account of costly fuel and power—to allow of manufacture for shipment beyond the local market.

With the opening of the oil fields in southern California, all this has been changed so that the process industries of the Coast can now sell in the world markets. To the hundreds of millions of dollars that flowed back into California as the "black gold" flowed from its wells to all parts of the world may be credited the start of the phenomenal development that has blessed the Coast in recent years, a development that has changed it from an easy-going community of the old Spanish type of civilization to a highly industrialized community where gigantic tire factories are surrounded by orange groves and vineyards and where million-kilowatt hydro-electric enterprises spring from glacier-fed streams that flow through a sportsman's paradise.

Money from oil paid for water and irrigation systems, orange groves and vineyards, hotels and land developments. People came to the Coast and found joy in living in California's famous climate and among the green forests of Washington and Oregon. To feed and give employment to these visitors and new citizens, numberless new enterprises were started, enterprises ranging from the little one-family apple orchard or vineyard to gigantic process industries such as the Standard Oil Co. (California) or the Crown-Zellerbach Corp. with its pulp and paper mills located along a front of 2,000 miles, from southern California to northern British Columbia and Alaska.

Petroleum is the great source of power in the Pacific Coast region. Now that wise conservation measures and regulations enforcing the utilization of oil-well gas are in effect, the petroleum resources of the Coast promise to be ample for all needs for decades to come. Oil and compressed gas are now being shipped long distances at low cost. For example, current quotations on deliveries in Seattle include: fuel oil, $1.09 per barrel (18,500 B.t.u. per lb.); liquefied gas, 9c. per gallon (equivalent to 40c. per M cu.ft. of a 500-B.t.u. gas). Prices are lower, of

Available Water Power in United States, Both Developed and Potential; Each Dot Represents 100,000 Hp.

course, nearer the oil fields in California, Montana, and Wyoming.

While coal has been mined since the earliest days in every part of the Coast region, the actual development has been slight and the resources have hardly been scratched. The grades range from lignites, through the coking coals, to true anthracite. The great coal fields of Alaska, British Columbia, Washington, Oregon, Utah, Colorado, and northern California may be classed as latent resources ready to be developed and utilized whenever cheaper and more convenient sources of power become depleted.

Steam coal of around 11,000 B.t.u. per lb. has sold in the Puget Sound region for as low as $1.25 per ton, but the present quotations are much higher, on account of restricted mine operations. With a little shopping around a large buyer can get satisfaction both as to type of coal and price.

Wood refuse and water power are the two sources of energy that, while definitely limited in total amount in the Coast region, will never become depleted as will coal, gas, and petroleum. There was a time when thousands of wood refuse burners stood a challenge for the chemist, and a source of grief and expense for the timbermen. Now, with the advent of the wood "hog" and the pulp mill, this wood refuse has become far too valuable to destroy in the refuse burners.

Scientific reforestation and logging on the sustained-yield system means that the timber resources of the Pacific Northwest—and in turn the water-power resources—will be kept approximately constant for all time to come. For example, in western Washington, Oregon, British Columbia, and southwestern Alaska, the climatic conditions are such that pulp wood grows 12 in. or more in 40 years, and lumber species can grow to commercial size in less than 100 years.

Charcoal suitable for process industries can be made from waste wood, the cost being around $5 per ton. Where waste wood is "hogged" and used as fuel, it is sold on the basis of the "unit," a unit being 200 cu.ft. of chips and sawdust loose packed as falling into a car or barge. A unit will average 17,500,000 B.t.u. and sells for 50c. up, the cost being mainly a matter of handling and transportation.

Water-power projects on the Coast have, with a few exceptions, been developed primarily for public utility purposes and not for serving any one power-using industry. This has resulted in a step-by-step development of the smaller power streams in units of a few thousand kilowatts each. The linking together of these relatively small units through long inter-tie lines has resulted in the formation of a few great systems, all having a similarity of interests and working closely together, so that now the whole Coast may be considered as served by one power system.

This has been an orderly and proper development when considered solely from the utility point of view, but the production cost of power as delivered to the Coast industrial centers has of necessity been high when compared with power costs at Niagara or in Norway and Switzerland. Thus the quoted rates have not been such as to be attractive to the large power-using industries. This condition is rapidly changing, on account of the developments now under way on such immense power streams as the Skagit and Columbia in Washington, and the Colorado in California and Nevada. The Skagit development, with an ultimate capacity of 1,120,000 hp., has made possible industrial rates as low as 4 mills per kilowatt-hour, or even lower, depending on the demand and the season.

Financing of the full power development of the great streams of the Pacific Slope is justified mainly on the need for flood control or irrigation, or both. Immense blocks of various classes of power at low rates will thus doubtless become available for the process industries. What the development of these Pacific Coast power streams will mean to the power-using industries will be evident from a study of the accompanying map. Washington stands first among the states in potential water power, followed in order by California, Oregon, and New York. The waters flowing into the Pacific account for 69 per cent of the 38,000,000 hp. yet to be developed in the United States. Of the 12,300,000 hp. already developed, Pacific Coast streams supply a third of the country's total.

Rock Island Power Plant, Columbia River, Wash.; Initial Capacity, 84,000 Hp.; Ultimate Capacity, 252,000 Hp.

Mechanical Sacking and Loading Station for Borax and Potash

Boarding House and Coffee Shop in Company Village

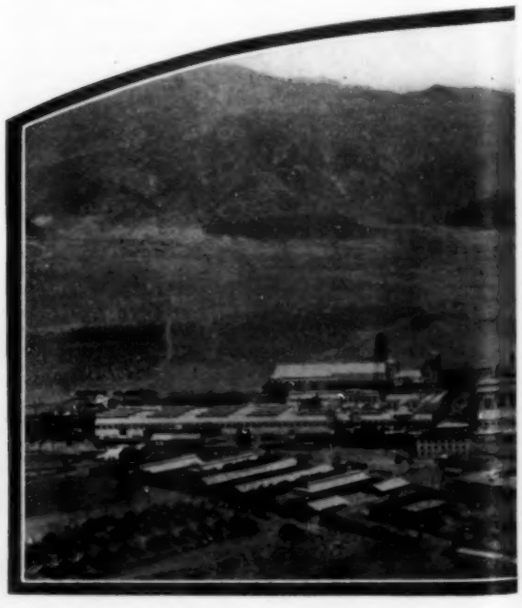
Trona Expands Borax and

WHEN that genial philosopher and master of applied physical chemistry, the late Dr. John E. Teeple, succeeded in perfecting the commercial process for recovering borax and potash from the brines of Searles Lake, the plant of the American Potash & Chemical Corp. at Trona, Calif., had a daily capacity of about 85 tons of potassium chloride and 45 tons of borax. A few years later (in 1926) the management undertook the tremendous task of enlarging and completely rebuilding the plant without interrupting normal production. In 1929, when Dr. Manning described the operations at Trona (See *Chem. & Met.*, May, 1929, pp. 268-72), the capacity had been extended to 240 tons of potash, 130 tons of borax, and 25 tons of boric acid per 24 hours.

A year later (in 1930) the company embarked on still another expansion program, and when *Chem. & Met.'s* representatives again visited the plant, July 25, 1931, the new construction was well along toward completion. It is to

Looking North Over American Potash & Chemical Corp. Plant and Village

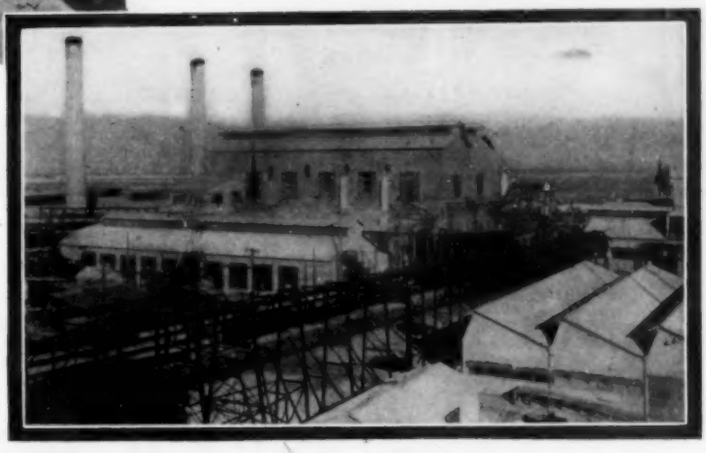
This Overhead Structure Carries all Pipe and Power Lines



Aerial View of Plant and Village Showing New Construction Under Way

Bulk Storage of Potash Salts in New Warehouse

Pipe Trestle From Potash to Borax Crystallizing Plants

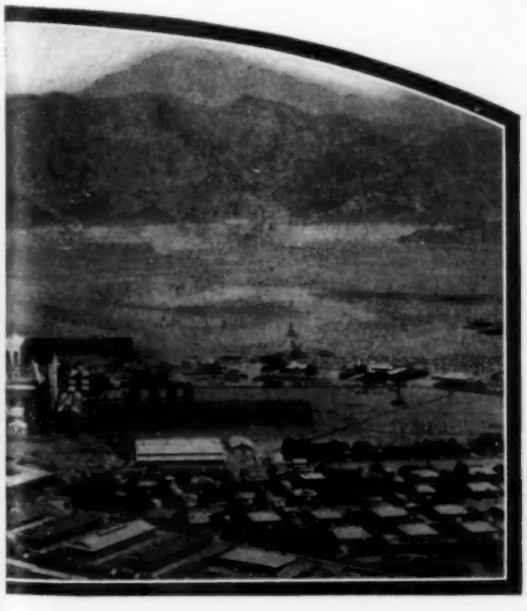


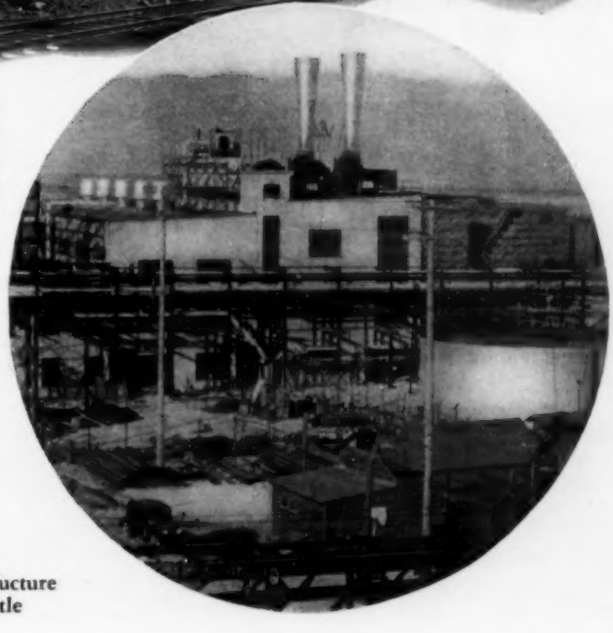
Capacity for Potash

be finished during 1931, at which time the daily capacity will have been increased to almost 400 tons of potash and over 200 tons of borax. The significant commentary is that the management has again succeeded in correlating this construction program with its normal operations so that there has been practically no interference with the production schedule. Much credit for this accomplishment is due also to the Dwight P. Robinson Co., who served as engineers and constructors in both the 1926 and 1931 expansion programs.

The illustrations on this page, prepared from photographs taken expressly for *Chem. & Met.'s* use by R. W. Mumford, consulting engineer of the American Potash & Chemical Corp., give a good idea of the extent and character of the new construction. For the privilege of their publication and for the many courtesies shown to its representatives, *Chem. & Met.* acknowledges its indebtedness to H. S. Emlaw, president, and Dr. W. E. Burke, superintendent.

New Power House With Total Generating Capacity 10,000 Kw. at 80 Per Cent Power Factor and 6,600 Volts A.C.





Power House Structure and Pipe Trestle

Science Building, University of Southern California, Los Angeles

Western Education Contributes Original Chemical Courses

By WILLIAM N. LACEY

Professor of Chemical Engineering, California Institute of Technology Pasadena, Calif.

THE PACIFIC COAST STATES are young educationally as well as industrially. This fact implies interesting possibilities of growth and development. It also necessitates the judgment of present conditions in the light of a partially completed structure rather than one fully established and recognized as a finished product.

Chemical engineering education as developed in a particular community must necessarily be interrelated with its industrial development and with the opportunities offered for education in the physical sciences. One of the greatest spurs to scientific education is the joy of the individual in utilizing his acquired knowledge either to extend our perception of natural phenomena or to make useful application of available facts. A community, therefore, which abounds in opportunities for development is an ideal setting for educational activities. The Pacific Coast, with its stores of raw materials, favorable climatic conditions, and proximity to undeveloped markets, offers a challenge to its educational institutions to develop men equipped for the future extension of its already thriving chemical industries.

Although it is the author's aim to outline the present status of chemical engineering education in the Pacific states, it must be remembered that many important developments in the chemical industry, even in its engineering phases, have been contributed by men who had their training as chemists rather than as chemical engineers. For this reason, the discussion will also include opportunities for education in chemistry.

The degrees pertaining to chemical studies granted by the larger colleges and universities are summarized in Table I, as far as information was available to the author. In Table II is a classification of the requirements of the four-year undergraduate courses in the six institutions offering degrees in chemical engineering.

The University of Washington, in Seattle, was one of the earliest institutions on the Pacific Coast to undertake education in chemical engineering. It

Table I—Chemical Degrees Granted Annually (Average for Last Three Years)

Institution	Chemistry	Chemical Engineering
Univ. of Washington	25	13
State College of Washington	10	5
Univ. of Oregon	(1)	*
Oregon State College	†	17
Univ. of California (Berkeley)	42	*
Stanford University	11	
Univ. of California (Los Angeles)	10	*
Univ. of Southern California	20	6
California Inst. of Technology	10	15

(1) Blank spaces indicate lack of information; *degree not offered; and † no degrees granted.

Table II—Requirements for Bachelor's Degree in Chemical Engineering Courses

Institution	Semester-units Required[1]								
	Mathematics	Physics	Chemistry[2]	Engineering[3]	Language	Business Studies	Cultural Studies	Research	Elective
University of Washington	12	10	43	47	0	0	2	0	12
State College of Washington	16	10	42	34	0	4	12	0	10
Oregon State College	18	6	40	34	0	6	6	6	12
Stanford University	10	8	32	20	14	0	15	0	21
University of Southern Calif.	16	14	23	26	0	3	12	0	16
Calif. Institute of Technology	16	16	38	15	12	5	24	0	6

[1] Each corresponding to 3 hours work per week for half college year, including allowance for classes, laboratory and preparation.
[2] Including Industrial Chemistry. [3] Including Chemical Engineering.

has offered degrees in this specific field for 25 years. In the undergraduate curriculum are included a sophomore course in chemical stoichiometry and technology, a junior course in industrial chemistry (three lectures and two laboratory periods for a year), a senior course in unit operations (three lectures for three quarters and two laboratory periods for two quarters), and a thesis problem for at least five quarters.

The State College of Washington, situated in Pullman, offers both chemistry and chemical engineering. The chemical engineering curriculum includes a lecture course in industrial chemistry. No laboratory courses are given, on the principle that laboratory technique in this field can better be gained in the industries after graduation.

In Oregon, legislative enactment prescribes that the chemistry curriculum be given at the university at Eugene, while industrial chemistry and chemical engineering curricula are allocated to the Oregon State Agricultural College, at Corvallis. Although the former institution offers only a chemistry course, the department is under the direction of a man who has made important contributions to the chemical industries. At the State College the chemical engineering curriculum is designed in substantial agreement with the recommendations of the American Institute of Chemical Engineers. The alternate course in "industrial chemistry" offers more choice of subject and is intended for those students who wish to emphasize chemistry rather than engineering. Within the subjects offered by the chemical engineering department the industrial chemistry and introductory chemical engineering courses call for both class and laboratory work. More specific and advanced courses in the chemical engineering field are offered, as well as opportunities for thesis and research work.

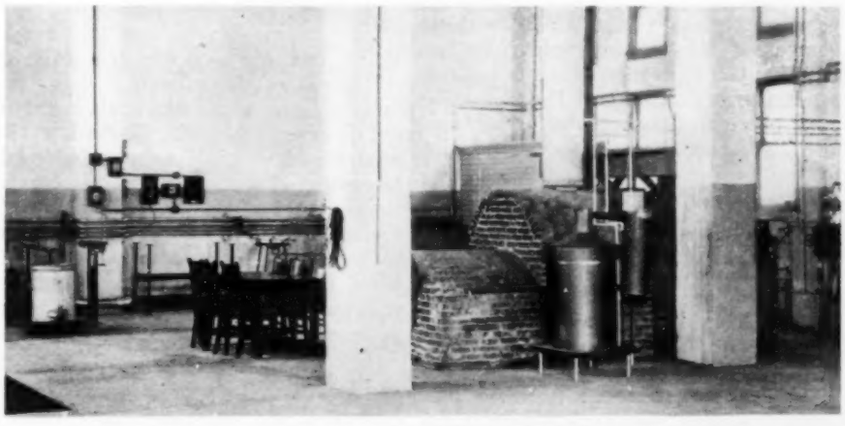
The University of California maintains two campuses, the older one at Berkeley and the second one at Los Angeles, but does not offer degrees in chemical engineering at either institution. General engineering courses may be taken as electives at Berkeley. There, also, are given three courses in industrial chemistry, one of which is a laboratory course. The industrial chemistry laboratories make good provision of large-scale equipment and facilities for both instruction and research. At Berkeley is found also a strong undergraduate and graduate school in physical chemistry. The chemistry department at Los Angeles is much younger than that at Berkeley but has been making rapid strides in the field of undergraduate instruction.

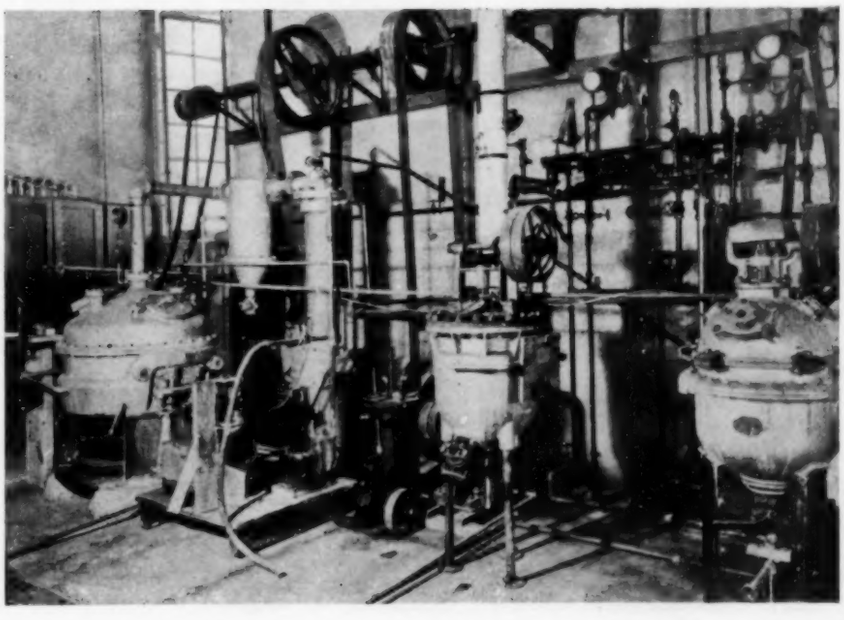
Stanford University, at Palo Alto, Calif., has offered degrees in chemical engineering for many years. More recently the name of the course has been changed to engineering chemistry. Up to the present the engineer's degree has been given after one year of graduate work, but hereafter two years will be required. No courses relating specifically to industrial chemistry or chemical engineering are offered.

The University of Southern California is located in Los Angeles. Besides the usual chemistry and engineering studies included in the chemical engineering course, there are offered one-semester courses in industrial chemistry, principles of chemical engineering, and petroleum technology, laboratory work being included in the last case.

The California Institute of Technology is situated in Pasadena. The curriculum is planned upon a somewhat different basis from the others cited, resulting in a differentiation of emphasis (see Table II). The underlying theory rests upon the premises: (a) Thorough grounding in fundamental sciences and adequate cultural background are both necessary to the engineer in his dealings with processes and with his fellowmen, and (b) sufficient training in both fields is all that can be crowded into four years' work, necessitating the postponement of more specific professional study to the fifth year. After four years the student may receive the B.S. degree in science, taking the chemical engineering option. Fifth-year work leads to the M.S. degree in chemical engineering, and includes a year's problem work in unit operations, a year's research, a year's course in business administration, together with further work in chemistry, physics, or engineering as selected by the student. The Ph.D. degree is not offered in chemical engineering, but this study is accepted as a minor for a Ph.D. in either chemistry or mechanical engineering. No organized chemical engineering laboratory courses are offered but semi-works scale facilities are provided for research.

There are a number of other institutions on the Pacific Coast offering satisfactory courses in chemistry. Space does not permit description of their work, although it should be said that their graduates are maintaining the supply necessary for Western development.





Chemical Engineering Laboratories: (Left) Oregon State Agricultural College, Corvallis; (Below) California Institute of Technology, Pasadena

Industrial Research for a Healthy Pacific Coast Industry

For the most part, the western process industries have early recognized the need and importance of research and have established such departments. The newness of operations, in fact, presupposes that many must have arisen from scientific investigation of products and markets. In the following review, two typical examples of industrial development laboratories to be found on the Pacific Coast are briefly described.

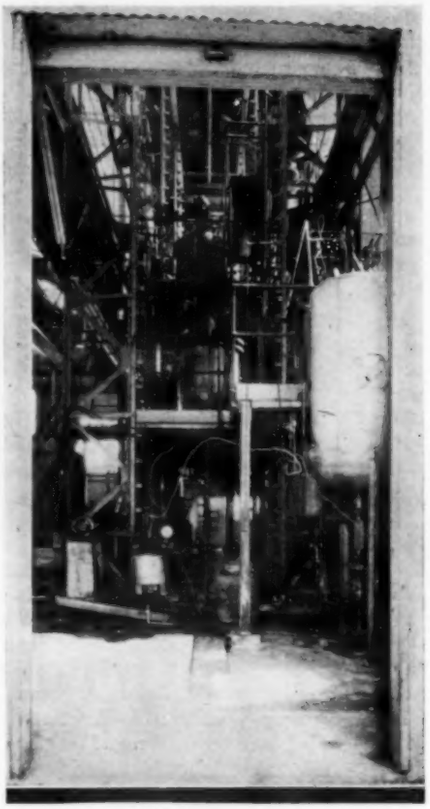
Petroleum Research as Basis For Shell Operations

A VISIT to the research laboratories of the Shell Development Co. at Emeryville, Calif., provides an excellent picture of coordination in scientific and technical effort for the development of new outlets for petroleum derivatives. The laboratories were erected during the latter half of 1928 to provide in America a central research station where fundamental work of interest to the entire Shell group could be carried out. The scope is not limited to the interests of any particular refinery or district but is concerned with the investigation and development of any desirable processes for the utilization of available raw materials in whatever direction may appear profitable.

The site chosen at Emeryville, an industrial center on the east shore of San Francisco Bay, adjacent to Berkeley and Oakland, offers several advantages. It is situated convenient to the central offices of the Shell organizations in San Francisco and to the Shell refinery at Martinez, whence raw materials can readily be obtained and where new processes, based on such raw materials, can be developed, step by step, to a commercial scale with continuity of supervision and control.

Since the laboratories have been in operation the Shell Chemical Co. has selected a site for its factory which also is within one hour's drive of Emeryville. As it is responsible for the commercial development and exploitation of processes evolved by the Shell Development Co., this geographical distribution is very convenient and practical without hampering the research effort by too close contact with the routine of a large producing organization. The favorable atmosphere for research is further fostered by the proximity of the laboratories to the universities of California and Stanford, offering the research staff the advantages of close contact with modern ideas in pure research and of extensive library facilities at the universities.

The Emeryville laboratories were designed to provide not only for research on a laboratory scale but also for the development of processes from the laboratory to semi-large-scale experimental plants. Several such plants are already in operation with capacities of from 50 lb. to one ton per day, according to the needs of the process. This semi-large-scale development work is carried out in some cases by the research worker who has developed the process in the laboratory, but more usually is handled by a separate department which, with the engineering department, is so closely in touch with the research workers that there is no break in the continuity of progress from the test tube to the experimental plant production.



View Into Chemical Engineering Laboratory, Shell Development Co.

Laboratory Buildings of Shell Development Co. at Emeryville, Calif.

The buildings at Emeryville, shown in the illustration, are of concrete construction throughout, the central block containing administrative offices, laboratory accommodation for from 40 to 70 trained workers, storage facilities, library, and the like. Separate buildings house the service facilities and in the rear is a spacious building which houses the semi-large-scale experimental plants. The buildings stand on a site of approximately four acres, which allows ample room for development for some years to come. The total floor area of the central laboratory block is 26,000 sq.ft., and of the semi-scale experimental plants, 3,000 sq.ft.

The guiding principle in all buildings has been to provide the maximum of flexibility and ease of adaptation to changing needs. This has been obtained by a simple layout which enables laboratories of any size in units of 10x16 ft. to be built. The rooms are divided by hollow-tile partitions which contain no permanent fixtures and can therefore be removed or altered at will. It is noteworthy that although all the usual

laboratory services are available at frequent intervals throughout the laboratory buildings, there are no permanent fixtures in the way of heavy furniture or equipment, and it is thus possible to adapt any floor space at short notice to the needs of the particular work in progress. The drainage system is simple and consists of standard cast-iron pipe lengths which, being fully exposed through the building, can be readily replaced. In the course of three years, only two pipe lengths were replaced.

The separate shed for semi-large-scale experimental work is similarly arranged in the most flexible manner, so that new plants can be built or taken down at short notice. For example, structural uprights of the shed are provided at intervals with fixed brackets to which working platforms or units of plant can be at once connected. The usual services of steam, water, gas, etc., encircle the shed and are provided with numerous offtakes to which local connections are made. The experimental shed includes a high section for the accommodation of tall towers or stills, and for the arrangement of plant levels so that gravity flow can be used to the utmost.

The personnel of the laboratory consists of the director of research, six group leaders, about 50 chemists, and a further staff that brings the total payroll to about 100. The work of the laboratories is, for the most part, concerned with the investigation of new processes or products and chiefly, up to the present time, with the processes designed to utilize the waste gases of the refineries or oil fields. There is in addition, however, a flow of problems submitted by the operating branches of the group in connection with refinery or other difficulties which, either because of their more fundamental interest or through lack of facilities in the refinery laboratories, are better dealt with at Emeryville. This direct contact with problems of manufacture is of value to the research laboratories and is likely to increase. Though a carefully considered balance here is desirable and mutually beneficial, it is equally realized that "almost all the investigations upon which modern industry has been built would have been crushed at the outset if immediate practical value had determined what work should be undertaken."

The Shell Development Co. is not directly concerned with commercial production or sales, because as any process reaches the stage of commercial operation it passes into the field of the operating companies of the Shell organization. The proper correlation of the research and development activities with those of the operating companies is procured by frequent meetings of the officers of the various companies.

In the initial stages of the development of new outlets, the best results are obtained by such cooperation between research and commercial staffs. There is thus a healthy fusion of interests where the two organizations meet.

Western Precipitation Co. Builds On Process Development

ALTHOUGH the Western Precipitation Co. conducts a business of international scope, it is essentially a Western institution, having its head office and laboratories situated around a garden court in the heart of Los Angeles. During the 24 years of its career in developing technical processes, some have grown to play an important rôle in industry throughout the world.

The company was organized in 1907 to develop the Cottrell electrical precipitation process by the inventor of the process, Frederick G. Cottrell, and his personal associates, E. S. Heller, Harry East Miller, and Edmund O'Neill. At the same time, the International Precipitation Co. was organized to serve as the patent holding company, and has so functioned ever since with regard to foreign patents. All of the stock of the International company now is held by the Western Precipitation Co. During the early years of the company, the pioneer development of the Cottrell electrical precipitation process was carried on by Dr. Cottrell, with the assistance of H. A. Burns, J. G. Davidson, and Walter A. Schmidt. During this same period the company also developed the electrical dehydration process for separating oil-water emulsions, which is now in general use throughout the petroleum industry. In the development of the dehydration process, Dr. Cottrell had the assistance of Buckner Speed and Allen Wright.

In 1911, Dr. Cottrell severed his connections with the company, to enter government service with the U. S. Bureau of Mines. The oil dehydration process was sold at that time to the newly organized Petroleum Rectifying Co., while the Research Corp., of New York, was established at the suggestion of the Smithsonian Institution to become the recipient of certain territorial patent rights to the electrical precipitation process which Dr. Cottrell had offered to the Smithsonian Institution as a foundation for the administration of inventions and new industrial processes in the public interest. At the same time the Western Precipitation Co. moved its headquarters from San Francisco to Los Angeles, as the principal work then in hand was the development of the precipitation process for the control of dust from a cement factory which was under litigation for alleged damage to orange groves in southern California. After a satisfactory solution of the cement dust problem had been achieved, the activities of the company expanded rapidly, and electrical precipitation installations have found application in many smelters and chemical works the world over.

In the course of this expansion the company has built up a well-rounded technical organization to handle the many problems which arise from day to day. At present the directors are Walter A. Schmidt, Arthur P. Knight, C. L. Ely, Evald Anderson, and Harry V. Welch. Kenneth I. Marshall is chief engineer, and George H. Horne is in charge of electrical development, while Norman M. McGrane is in charge of chemical development.

The company during the past twenty years has conducted a large amount of development work on numerous metallurgical problems, and on the recovery of byproduct potash, especially in conjunction with cement manufacture. It is also responsible for a highly successful process for the manufacture of ultrafine zinc dust used in the precipitation of gold and silver from cyanide solutions. More recently it has developed a highly efficient mechanical dust collector operating on cyclonic principles. The company now also handles the spray drying process invented by David D. Peebles, of Eureka, Calif. The laboratory and technical staff of the company have done a large amount of consulting and research work for Western industries. A separate staff is situated in New York.

In addition to its own direct operations, the company is interested in the Allied Process Corp., of New York, and, in connection with the world development of the electrical precipitation process, the company is associated with the International Precipitation Co., of Los Angeles; the Research Corp., of New York; Lodge-Cottrell, Ltd., of London; Metallgesellschaft, of Frankfurt; Siemens-Schuckert Werke, of Berlin; and the Japanese Cottrell Corp., of Tokyo.

Chemical Industries That Distinguish the West

Some of the outstanding new industrial achievements of the Far West have been considered in detail on the foregoing pages. Other chemical enterprises, with developments perhaps less momentous in scope, have nevertheless pursued their own unique careers and in their healthy growth continue to shed a characteristic light on the Pacific Coast industrial scene.

Intensive Barium Technology for Industrial Needs

By W. N. WILLIAMS

Resident Manager, Barium Products, Ltd.
Modesto, Calif.

DURING the year 1910 approximately 850 tons of barite (natural barium sulphate) was shipped from the deposit of the Yosemite Barium Co. at El Portal, in Mariposa County, Calif. This was the first barium ore commercially produced on the Pacific Coast and its production marked the beginning of an industry which has since grown to a place of importance in western industrial activity. In spite of the general curtailment of trade, nearly 25,000 tons of barite will be consumed on the Pacific Coast during 1931, practically all of the ore being used in California.

The chief uses for barite on the Pacific Coast are: (1) for preparation of heavy "muds" used in oil-well drilling, to prevent escape of gas and oil while the well casings are being placed; (2) for chemical manufacture including lithopone, blanc fixe (precipitated barium sulphate), barium peroxide, and other barium chemicals; and (3) as the base material for various pigments and fillers used in paints, rubber goods, and linoleum.

The barite used on the Coast without chemical processing, as a pigment and filler, amounts to several thousand tons annually. The ore used for this purpose usually is air- or water-floated or acid-treated to remove impurities, the finished product being marketed in various degrees of fineness, depending on the purpose.

The National Pigments Co., a subsidiary of the National Lead Co., is the largest producer of barite on the Coast. While a considerable tonnage of crude barite is sold as such, the greater part of the ore now produced at El Portal is ground to 300 mesh and water-floated to remove silica and other impurities. After drying and screening, this finely ground barite is sacked for shipment to mixing plants, where the mixture used for oil-well "muds" is prepared. The National Pigments ore-treating plant is of modern design, the capacity of the plant being 8 tons of water-floated barite per hour.

The Chemical & Pigments Co. is the only Pacific Coast manufacturer of lithopone, but it also turns out a considerable tonnage of water-floated, bleached barite. The company operates its own barite deposit in northern California, the ore being shipped to Oakland by rail. The plant is up to date in every respect and is well equipped to supply the substantial Coast market for lithopone. Practically all of its products are consumed on the Pacific Coast.

The activities of the Barium Products plant at Modesto, Calif., have expanded considerably since it was acquired a short time ago by United Chemicals, Inc., of New York. The products now manufactured in substantial quantities at this plant include barium peroxide, blanc fixe, barium carbonate, hydrogen peroxide, and sodium sulphide. The plant is happily situated with regard to ore supply, being but a short distance from the huge National Pigments deposit at El Portal. Since large amounts of power are consumed in the process used for manufacture of barium peroxide, location of the plant in the Modesto irrigation district has proved of great advantage because of the low power rate which the district's public-owned water and power company is able to quote. Part of the barium peroxide produced at Modesto is shipped East, the rest being converted into hydrogen peroxide.

The decision of Barium Products to enter the blanc fixe business was welcomed by the major users of this product—the rubber companies—since there had previously been no Pacific Coast supply of this important commodity. In addition to its use in the compounding of rubber, blanc fixe finds a substantial market in the Pacific Coast paint, paper, and ink trades.

The main use for barium carbonate is in the ceramic industry, where it is used to prevent efflorescence by precipitation of soluble sulphates. The sodium sulphide obtained at Modesto as a byproduct of the manufacture of barium carbonate is readily marketed in the western states, the main uses being as a depilatory and as a flotation agent in some mining processes.

The American Development Co., Ltd., of San Francisco, produces a number of non-metallic minerals, including barite, from its deposits in Nevada. The non-metallics are converted to marketable form at the company's grinding plant in Berkeley, Calif. Barium products comprise 20 to 30 per cent of the company's output, the chief products being ground crude barite, air-floated barite, and barium plaster. The untreated ground ore is sold chiefly to the glass industry and the air-floated barite to the paint and linoleum trades.

The Pacific Coast barium industry owes much of its progress to the rapid

National Pigments Company Ore-Treating Plant at El Portal, Calif.

Barium Products, Ltd., Plant at Modesto, Calif.

development during the past decade of the important Coast industries which it serves—namely, the oil, paint, and rubber industries. A factor that augurs well for the future of the industry is the plentiful supply of barium ore in California and neighboring states. Development work at the deposits of the National Pigments Co. and the Chemical & Pigments Co. in California indicates that enormous tonnages of barite are available, and the American Development Co. reports substantial quantities of high-grade ore in its holdings in Nevada. Paso Baryta Mines, Ltd., of Merced, has recently started shipments from what is reported to be a huge deposit located in the southeastern corner of Tulare County, Calif.

Western Chemicals Fertilize Western Produce

By J. F. C. HAGENS

President, Great Western Electrochemical Co.
Pittsburg, Calif.

BECAUSE the Pacific Coast and the Hawaiian Islands have for many years been regions of intensive farming, the application of chemical fertilizers was recognized to be a profitable investment. This was particularly the case in the Hawaiian Islands, where large quantities were used on sugar plantations under the direction of a scientifically managed agricultural experiment station. In California, at a later date, fertilizers were applied in considerable quantities for the more valuable crops such as citrus and deciduous fruit, as well as some field crops. Similarly the agricultural experiment station of the University of California was responsible for introducing the proper methods of fertilization.

In the beginning of this century the fertilizer business was dominated largely by the manufacture and distribution of the so-called mixed goods. These consisted of the principal fertilizer materials such as ammonium sulphate, nitrate of soda, chloride and sulphate of potash, and superphosphate. Organic fertilizer material, such as packing-house and agricultural wastes, were often added to these mixtures as fillers, and for this reason we find the large packing houses prominently identified with this business.

Among the leading superphosphate manufacturers were a Pacific Coast branch of the American Agricultural Chemical Co., the Union Superphosphate Co., the Pacific Guano & Fertilizer Co., and the Mountain Copper Co. Some of these manufacturers used phosphate rock from Idaho, others rock from Florida. Some of these concerns have disappeared either by merger or by closing down and today there are only left the Pacific Guano & Fertilizer Co., with factories in Honolulu; the Union Superphosphate Co., at Stege; and the Mountain Copper Co., at Martinez, the latter using its own sulphuric acid and phosphate rock from its own mines in Idaho.

The advent of synthetic ammonia changed the entire aspect of the fertilizer business. Sulphate of ammonia is now produced synthetically and the efforts of manufacturers have been directed also toward the production of compounds in which the nitrogen is combined with other plant food elements in order to eliminate unnecessary bulk as filler. This is particularly important for distant markets, where high freight rates make it impossible to sell low percentage goods at competitive prices. As a consequence the older products, such as tankage, dry blood, and the like, have dropped in price.

The Pacific Coast played a prominent part in these developments. The American Potash & Chemical Corp., formerly the American Trona Corp., was the first to wrest a substantial part of the potash business in the United States from German and French producers. After slow beginnings and under expenditures of very large sums for pure research, this concern succeeded in manufacturing from the complicated Searles Lake brines a muriate of potash which is competitive with the German and French product. It offers 97-99 per cent muriate of potash and by the end of this year its daily production will range at about 400 tons per day.

The success of the American Potash & Chemical Corp. in potash manufacture brought with it a high-grade borax at low prices, making keen competition with the principal borax producer of this country, the Pacific Coast Borax Co. In an effort to compete effectively, the Pacific Coast Borax Co. then made a very thorough search for potash deposits. Its efforts were crowned with success by the acquisition of a spectacular potash deposit near Carlsbad, N. M., where a sylvite vein of 30-40 ft. thickness and covering many square miles was discovered at a depth of about 1,000 ft. The crude mine run goes as high as 30 per cent K_2O and some of this material is marketed already by the United States Potash Corp., a subsidiary of the Pacific Coast Borax Co. or Borax Consolidated of London. A refinery is in course of erection at the present time near Carlsbad with a capacity of 400 tons of salt per day containing 99 per cent KCl.

Important developments took place in the phosphate industry, while not directly on the Pacific Coast, still in territory adjacent and contributory to it. The Anaconda Copper Mining Co., in order to utilize its sulphuric acid from smelter fumes at Anaconda, Mont., acquired large deposits of phosphate rock in Idaho and utilizes them in the manufacture of high-grade phosphoric acid and double superphosphate.

Also, under the pressure of having to utilize its smelter fumes, the Consolidated Mining & Smelting Co., of Trail, B. C., has just put into operation large units for the manufacture of phosphoric acid, double superphosphate, ammonium phosphate, and ammonium sulphate. The ammonia necessary for these products is also manufactured in Trail synthetically from electrolytic hydrogen, which is possible because of the availability of cheap hydro-electric power.

The latest development in the fertilizer industry on the Coast is the completion by the Shell Chemical Co., subsidiary of the Shell Oil Co., of a large plant for the manufacture of synthetic ammonia from hydrogen produced by thermal decomposition of natural gas. The process chosen is that of the German combine, Mont Cenis. The Shell Chemical Co. built two units, each with a capacity of 40 tons anhydrous ammonia, but of which only one is in operation now. The bulk of the material will be converted into sulphate of ammonia, the rest disposed of as anhydrous ammonia for manufacture of nitric acid and other industrial uses.

California's Diatoms Supply a Wide and Varied Market

By MINER L. HARTMANN
Consulting Chemical Engineer
Los Angeles, Calif.

DIATOMACEOUS earth, diatomaceous silica, kieselguhr, and diatomite are all alternative names for a natural mineral occurring in the sedimentary rocks of every age and in every land. It was first made an industrially important engineering material by the characteristic aggressiveness of a southern California producer. True, nature most generously assisted by preserving the fossil diatoms in only a very few locations in the form and purity which have been proved to be most useful to industry. California was favored in particular with the best of these. But the conquering of the natural obstacles of isolation of deposits, distance from the chief regions of manufacturing activity, and the development of diversified markets and specialized manufactured products, permitting economical large-scale operations, must be credited to the faith and foresight of the financial and engineering executives of the pioneer producer, the Celite Co., which was largely responsible for the development of the industry.

Diatoms are microscopic plants which live in both fresh and salt waters and are related to brown algae. There are numerous species—some 10,000 have been identified—but many species have come through the geologic ages without perceptible structural change. When these microscopic plants died, their siliceous skeletons were deposited in beds and finally compacted into soft rock. Sometimes clay or silt or extraneous sediments were deposited simultaneously, or the earth's movements were such that the material was greatly compressed, or soluble salts were deposited or precipitated within the diatom stratum, making the deposit not satisfactory for the use of our present age.

In southern California, and in particular at Lompoc, the site of the Celite Co.'s operations, enormous beds as much as 700 ft. thick are found deposited and preserved under conditions affording unusual purity, so that they now form an inexhaustible supply of highest quality material. This is not the only deposit of high purity, to be sure, but it is admittedly the largest deposit of a quality satisfactory for the trade which has been built up.

Not alone is the chemical purity a criterion of quality, although it is an important factor, but more important in practical use is the particular structure of the diatom itself and its condition; i. e., whether or not its fragile structure has been broken or crushed in the earth movements following its deposition. The most satisfactory diatom forms seem to be those plants which lived in salt water. Their skeletons are thinner in section and offer more surface for a given weight. The variety known as *Coscinodiscus* predominates in the best material from Lompoc.

Value Depends on Porosity

The characteristic of diatomaceous earth which gives it commercial value is its porosity, which in turn is a function of the high surface per unit of weight. The true specific gravity of the hydrated silica of which fossil diatoms are composed is approximately 2.1. A cubic foot of this material, with no pore spaces, would weigh 131 lb. Diatomaceous earth blocks cut directly from the banks from the best material weigh as low as 26 lb. per cubic foot. A good quality of powdered material in the form of a filter cake will weigh as low as 14 lb. to the cubic foot, equivalent to a porosity of nearly 90 per cent. As taken from the deposit, the apparently dry, light-weight rock will contain about an equal weight of absorbed water.

The light weight of the material in block form, just as it is cut from the banks, led to a successful and unique product, the well-known "natural" insulating brick, which has found a useful place in many types of industrial furnace, as a heat insulator. The processes involved in cutting, transporting, sizing, and drying the finished bricks are highlights of a visit to the Lompoc plant of the Celite Co.

Properties of light weight, infusibility, and chemical inertness of diatomite are utilized in several other heat-insulation products. A furnace-insulating brick is made by coarsely crushing some of the wet material, slightly contaminated with clay, remolding to brick shapes, and firing in a tunnel kiln. These bricks are heavier than the natural rock, but will withstand a higher temperature without shrinkage. Such brick are sometimes lightened by mixing in some organic filler, such as cork or sawdust, which is burned out in the kiln firing, leaving cavities where the filler particles had been. The powdered material is also used with magnesia and other bonding agents in the manufacture of molded and dried low-temperature blocks, pipe covering, and the like; and loose, for filling partitions and walls for insulation against heat and sound.

The qualities of lightness, high porosity, and chemical inactivity are the basis of the usefulness of diatomite in the filtration of industrial liquids. It is supplied in powdered form, and only the highest quality material, chemically and structurally, can be successfully used for this purpose. The powder is suspended in the liquid to be filtered, forming a soft, porous filter cake which prevents the clogging or sliming of the surface and permits longer filtration cycles and better clarification. Other grades of filter-aid have also been developed which permit three to five times faster flow of the clarified liquor through the filter presses. Clarification is not so perfect as with the "raw" diatomite but it is commercially satisfactory, and more economical.

Grinding the soft natural rock so that the desirable microscopic diatom structure is not injured and so that the desired porosity of the finished powder is not reduced by too many extremely fine particles is a problem on which

Plant of the Pacatome Co., Bradley, Calif.

much effort has been expended. Coupled with this problem is that of drying out 1 ton of water for every ton of powder made. It is neither economical nor satisfactory to dry in lump form and grind afterward. Once the surface of the lump is dried, an efficient heat insulation for the inside is formed and drying proceeds exceedingly slowly. The pulverized powder from dried lumps is badly broken, "diatomatically" speaking, and excessive fines are produced. The system which has been evolved is one in which the wet lump material is crushed to about ½ in. and finer in a swing-hammer mill, then dropped into a strong current of hot air on the suction side of large paddle-wheel blowers. The moisture is quickly driven from the material and the lumps are broken to powder by the impact of the fan blades. This blower discharges its partly dried powder and moist air into a large cyclone dust collector. The powder is collected, and the moist air and dust are discharged to the atmosphere (if near-by inhabitants do not object) or otherwise handled for the recovery of the dust. The partly dried powder is again fed into a stream of hot air on the suction side of another blower and again collected in a cyclone. This time the air and powder are sufficiently dry so that the dust may be collected in cloth filter bags and recovered for use as fine mineral filler or as polish powder. In the interests of conservation of heat, and also for the purpose of removing more of the undesired fines, the heated air from this cyclone is frequently returned to the system, and the powder passed through a third blower and cyclone, after which it is packed by mechanical packers in heavy burlap or multiwalled paper bags.

Improved Filter-Aids Calcined

Patented, improved filter-aids are made by calcining the powdered material after it is dried and pulverized, as above. Since the dry powder is such an efficient thermal insulator, calcining is difficult. Large rotary, brick-lined kilns, from 100 to 130 ft. long and 5 to 7 ft. inside diameter, are used. These kilns are fired by gas or oil, and the temperature and time of calcination are closely regulated to permit incipient sintering of the thinnest edges, but to avoid agglomeration. Heating strengthens the particles and sticks together the finest dust so that in use it does not clog the filter cake. Some of these products are made by this simple calcination, while with others, fluxing materials such as soda ash, are added.

Filtration of sugar liquors in refining is one of the principal uses for diatomaceous earth filter-aids. From 4 to 8 lb. of filter-aid is consumed for each ton of sugar refined. The filtration of oils of all kinds, water, salt solutions, varnish, sewage, oil and water emulsions, and industrial liquids of almost every kind has been improved and simplified similarly.

Many miscellaneous uses have been developed for the material of different qualities. Every automobile carries around a few pounds of diatomite in the asphaltic composition of its battery box—a use which in the aggregate probably takes more diatomite than any other single use. The fine powders and the "bag-house" products are used in many kinds of polishes, abrasive and scouring soaps, as flattening agents for varnish, in match-head compositions, as fillers in various plastics, as supporting agents for catalysts, and in innumerable other ways.

One application which held promise at one time of being the most extensive was as an ingredient in concrete and mortars. In these it functions to increase the plasticity or "workability" without injury to the properties of the concrete. When added as a fine powder to the extent of 3 to 5 lb. for each 100 lb. of cement used, it combines with the lime freed by the hydration of the cement when mixing water is added, giving a gel which lubricates the sand and rocks. A more uniform concrete results, and one of higher strength, because the same workability can be attained with less excess water in the mix.

This use, while perfectly sound and practical, as was proved by exhaustive tests and trials, has not increased to the extent at first expected, probably due to the letting down of research and sales effort which marked the initial introduction of the material. The results attained, particularly on the Pacific Coast, where concrete exterior finishes have been more extensively used than elsewhere, seem to justify the statement that diatomite is an important ingredient in concrete and has a distinct place in concrete building construction.

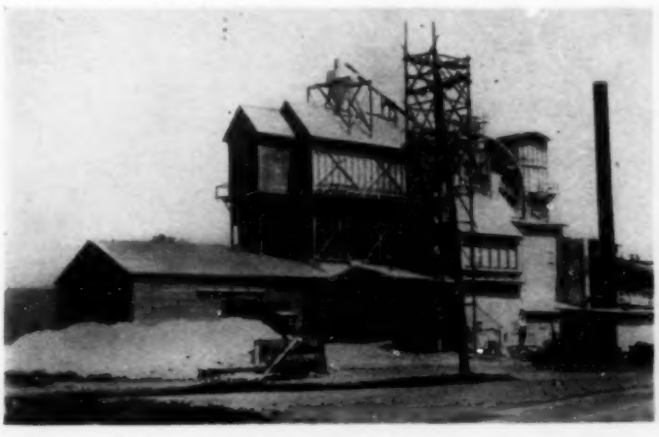
In 1910, the California production of diatomite was about 2,000 tons, which had increased to about 130,000 tons in 1929, valued after manufacture into marketable products at some $4,000,000. In 1930 and the current year the production has undoubtedly been somewhat lower, as the world-wide reduction in industrial activity has been felt by this industry. These statistics of the diatomaceous earth industry are emphasized as there have been so many grossly exaggerated estimates of the total consumption of this product.

Celite Chief Producer

The history of the industry is almost identical with the story of one pioneer company, the Celite Co., of Los Angeles and Lompoc, which in the past has produced some 75 to 90 per cent of the world's production. In 1928 this independent company was acquired by the Johns-Manville Corp., which has continued the manufacture and sale of the original products.

As might be expected, numerous sporadic attempts were made during the early years of the industry to develop other deposits and reap the rewards of the pioneering efforts. Many of these have been the rankest kind of fly-by-night promotions; some have been sincere, although oftentimes misguided, efforts to develop competitive sources. On the Pacific Coast there are at the present time several plants more or less completely equipped to supply the several grades of diatomaceous earth powders, among which may be mentioned the Celite Corp. (Johns-Manville Co.) at Lompoc; the Pacatome Co., at Bradley; the Dicalite Co., at Los Angeles; the Calatome Co., at Monterey, and the Atomite Co., at Terrebonne, Ore.

Increasing importation of foreign diatomaceous earth material (duty-free and at very low ocean freight rates), which for many purposes is not equal in quality to the best West Coast production, has greatly hampered the smaller operators. Some of the Algerian deposits, the chief foreign source, are now controlled by the same interests that dominate the West Coast production, which creates a very difficult competition for the newer and smaller concerns. As in the past, any further expansion of the industry, particularly of the smaller units, must be built on the same basis of continuous product and market research which was responsible for the original growth.



Plant of the Dicalite Co., Near Los Angeles

Mojave Desert Yields a New Ceramic Body

By T. S. CURTIS
Vice-President, Vitrefrax Corp.
Los Angeles, Calif.

Natural Porcelain Body for Many Centuries of Vitrolon Manufacture

IN HARMONY with the new idea in research, production, and sales, born doubtless as a result of the urgent necessity for change created by the general business depression, West Coast manufacturers of ceramic wares have recently taken the leadership of the country in the development of whitewares of outstanding novelty and interest. Realizing that price-cutting competition and ordinary high-pressure sales methods had brought the industry to the point where its back was against the wall, a number of the leading ceramic concerns have adopted a complete reversal of the old-time sales tactics, after due periods of trial and error, with most gratifying and inspiring results from the standpoint of volume of business and prices obtained.

The fundamental idea has been the creation of something really new, rather than a mere dressing up of the same old articles in a new color, shape, or decoration. A conscientious effort has been made to subdue, or to eradicate entirely, those subtle defects which have been tolerated and excused in the general run of production under the old high-pressure methods of manufacturing and sales. The result has been the introduction into the market of wares of greater beauty, utility, and endurance than have heretofore been available, and at prices which, while showing a satisfactory margin of profit, are no higher than those obtaining for an inferior article before the crash came.

Credit for this constructive change may fairly be shared by the producer of the new ceramic raw materials which have made these developments possible (Vitrefrax Corp.), and by the score of capable, enthusiastic, and aggressive ceramic engineers in the various manufacturing plants whose cooperation and ideas have brought out the best in the new wares. Space will not permit of detailed technical descriptions of the improved products, but it may be of interest to note a few of the unique features that this cooperative industrial research has brought about.

From the production standpoint, the reduction of shop losses has been the primary object. To this end, a better control of color, cleanliness, size, accuracy of shape through the reduction of warpage and slumping, and alteration of the properties of plasticity or moldability without changing the shrinkage, have contributed measurable savings in the reduction of rejects and increase in percentage of first-grade ware.

From the merchandising standpoint, perhaps the most interesting angle has been the increase in what is termed "eye value." The new ware is beautiful in color, texture, and workmanship. But of scarcely less importance has been the enhancement of strength and toughness and the control of brittleness. As an example, two manufacturers of dinnerware are turning out a semi-vitreous table ware that has from double to treble the transverse strength of the ordinary ware, and many times the impact value, thus minimizing the danger of chipping, loss of handles on cups, etc., and in some measure eliminating the one great objection to semi-vitreous ware; that is, the uncleanliness of such ware on fractured surfaces with the attendant danger of bacterial development.

Troublesome and recurrent epidemics of crazing of the glaze in semi-vitreous ware are believed to have been completely eliminated in the new products. If the standard tests for crazing are to be relied upon, the ware may be described as craze-proof. And in oven ware for cooking, both in vitrified and semi-vitreous, the thermal shock value has been enhanced to a degree that permits one to fry eggs in a casserole over an open gas flame without the slightest danger of crazing or dunting.

Improvement in Tile Production

Production of tile of all descriptions has received a large share of attention with most gratifying results. Vitreous floor tile of surpassing beauty of texture and color are being manufactured in 2-in. and larger shapes with a reduction in weight of from 20 to 40 per cent by virtue of the greater strength and toughness of the body. A hexagon tile of $\frac{1}{4}$-in. thickness of the new production struck against a $\frac{3}{8}$-in. tile of the old body will completely destroy the latter without chipping the thinner tile, so great is the increase in toughness of the new body.

In the manufacture of large shapes of vitrified tile, warpage has been a serious problem. Elimination of it usually demands a shading of the degree of vitrification below that which is desirable or safe. The new bodies permit such tile to be made straight and true and virtually non-absorbent.

Sanitary wares have been benefited by greater accuracy of shape, freedom from warpage and slumping, and have been markedly improved in purity of color. Likewise in the multiplicity of

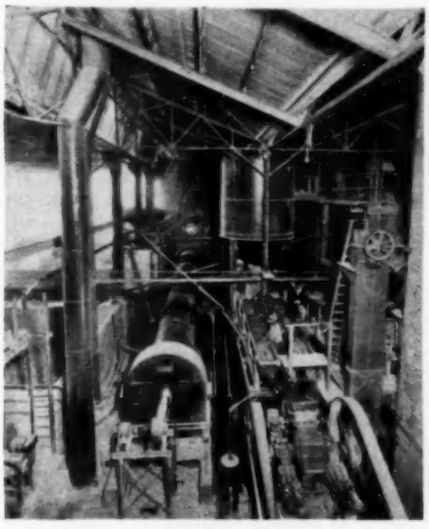
Vitrolon Raw-Material Storage With High-Temperature Silica Converters in Foreground

colors now demanded, marked advancement has been made in the control and quality of the colored glazes employed as a result of the new ceramic materials available. Possibly the most importance advance, however, has been the marked increase in resistance to thermal shock which permits sanitary ware to withstand severe changes of temperature in hospital service or elsewhere. Furthermore, this superior resistance to dunting permits small defects in the glaze to be refired without danger of dunts.

In the making of liners and balls for ball mills, the new body has proved to be exceptional because of its freedom from glassy texture and its thorough vitrification and great toughness.

Technology of New Bodies

Inception of "Vitrolon," as the new bodies have been trademarked, came as a result of seven years of investigation



Automatic Processing Equipment for Vitrolon Raw Materials

and experimental study of virtually every white-burning type of ceramic body in use in the world today. Samples were gathered from many quarters of the globe for a study of the variations in raw materials of supposedly uniform types, this study embracing the physical, chemical, and mineralogical properties of each. A special technique, believed to be unique in the field of silicate research, was developed to enable the reactions resulting from the application of heat to ceramic minerals to be observed through a microscope while in actual process of occurrence, and permanent records of this work were made in the form of motion photomicrographs.

As a result of this study, many of the puzzling anomalies of ceramic body characteristics were explained, since the behavior of microscopic particles of clays and non-plastics could be observed in the act of firing, both in combination with other minerals and each by itself. Much was learned of the influence of particle size and shape, of the relationship existing between minerals commonly employed as fluxes and those considered refractory, and of the rate at which particles of one would dissolve particles of another in melting. The technology thus established afforded a new vision of ceramic body structure and disclosed the interesting fact that two body compositions of exactly the same chemical analysis might have quite diametrically opposite physical characteristics.

The result, quite naturally, was the development of processes for the treatment of commonly used ceramic materials to enhance their stability, to remove certain characteristic faults that caused variations in quality or uniformity, and to combine two or more of these materials into a third with the properties of neither. Thus there came into being a new series of ceramic raw materials, obviously more expensive than those they displaced but of certain and measurable value when properly applied.

As the properties and uses of these new synthetic minerals became better understood, the market increased to the point where first cost became the only limiting factor. With the growing realization of the value of the fundamental idea came the ambition either to reduce the cost and thus broaden the market, or, to find in nature substances that, while heretofore valueless and unused in ceramics, might lend themselves either alone, or in combination with others, to the advancement of the plan which, simply expressed, was merely the substitution of stable for unstable minerals in ceramic bodies, thus placing less responsibility upon the final firing of the ware to bring out the desired qualities.

Since heat played a prominent part in the processing of the artificial minerals, it followed that their natural counterparts would be found, if anywhere, in a country characterized by volcanic activity in its geological history. In this respect, the desert regions of the Pacific Southwest probably afford a natural environment closely bordering a rapidly growing manufacturing community with cheap fuel, mild climate, abundant, cheap and happy labor, not to be duplicated elsewhere in the civilized world.

Search for Natural Mineral

Thus it came about that in the investigation, analysis, and testing of hundreds of samples of rock minerals from the Mojave and Colorado deserts there was discovered a prodigious deposit of what is believed to be one of the most valuable and uncommon ceramic minerals ever to be found. A natural frit or smelted mass of fine grained, pure white rock equaling in composition the necessary percentages of clay, silica, and feldspar to form a pure white, vitreous ceramic body of remarkable strength and toughness and of a degree of physical stability unapproachable by an artificial mixture of its three equivalents, this enormous mound of natural porcelain has an estimated supply of over 200 million tons. With slight modifications in plant technique, not a pound of foreign material would need to be brought to this deposit to permit of the manufacture of virtually every kind and type of white ceramic article made in the world today, since the mountain of ore is processed cheaply and with unerring uniformity into a plastic white-body composition of excellent working properties.

Processing New Ceramic Base

Development of this contribution of nature's furnaces into a standardized, perfectly controlled ceramic raw-material base has been the work of something over a year. Today the finished product is made in a mill of unique construction and design into which every safeguard ingenuity could devise has been built to insure cleanliness, uniformity and quality, irrespective of the human element that watches the operations.

To this remarkable new ceramic raw material, which forms the base of virtually all of the new ceramic wares previously described, is added standard china and ball clays in the desired percentages to make the new body conform to the old in working properties, shrinkage, maturing point, and so on. Where additional silica is required it is obtained from ordinary potter's flint in cases where the unstable properties of this mineral are not objectionable. In other cases, where flint or quartz would tend to neutralize the valuable properties imparted by the natural frit, a stabilized or converted silica is used. In certain bodies where special properties are desired, these may be obtained through the use of increasing percentages of the alkaline earth fluxes of which dolomite is the preferred source. A most interesting and somewhat unusual characteristic of the Vitrolon type of body is that relatively large quantities of earth fluxes may be employed without appreciably shortening the vitrification range.

Today, virtually every characteristic and property obtained two or more years ago through the employment of the expensive synthetic minerals may be obtained cheaply, and with certainty, through the use of the new natural ceramic base with smaller percentages of the more expensive synthetic minerals. Hence, a new era of ceramic development is dawning for the Southwest, with five prominent plants now in production with the new bodies, and others rapidly approaching this state, turning out wares of superb quality and endurance and thus laying the foundation for a business expansion and development founded upon sheer merit of product.

Pacific Glass Industry Specializes on Containers

By KENNETH M. HENRY
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Illinois Pacific Coast Co.
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IN THE EARLY eighties, the San Francisco & Pacific Glass Co. was organized to manufacture and sell glass containers. The glassware from this factory was the first to be produced on the Pacific Coast. Abramson & Heunisch, bottle brokers, bought an interest in the firm in 1896, and about the year 1904 the owners of the business disagreed. One group withdrew and formed the Pacific Coast Glass Co. The remaining group changed the name of the firm to the Illinois Pacific Glass Co.

The first glass plant of any magnitude to be erected in southern California was that of the Latchford Glass Co., in Los Angeles. This was followed by the Southern Glass Co. and the Long Beach Glass Co. Several small factories in the southern California field are manufacturing various novelties and, in some cases, glass containers. in 1929, the Hazel-Atlas Glass Co. established a branch plant in Oakland, Calif.

Finally, in 1930, the Pacific Glass Co. and the Illinois Pacific Glass Corp. merged, forming the Illinois Pacific Coast Co., which then acquired the Southern Glass Co. By virtue of the amalgamations, the Illinois Pacific Coast Co. became the largest on the Coast, with two three-furnace plants in San Francisco and two one-furnace plants in Los Angeles.

Several attempts have been made to establish factories in the Northwest, but all have failed, primarily because of economic conditions.

Emphasis on Container Production

All of the plants mentioned above have been equipped to manufacture bottles and jars. The production of flat glass, for some reason, has not met with much success, although at the present time there is at least one factory operating in the southern field and, according to newspaper reports, the Pittsburgh Plate Glass Co. is to build a factory for such production on the Pacific Coast.

Many of the major developments in methods and machines now found in the glass industry as a whole were worked out wholly or in part by the Illinois Pacific Coast Co. and its predecessors. The invention of the Owens machine in the East, many years ago, was the beginning of the machine age in the glass world. This machine was inherently ill adapted to the needs of the Pacific Coast manufacturer, because for economical operation it demanded long, continuous runs, whereas the western plant had to be designed for short runs and to produce all of the many varieties known to the glass container field.

West Develops Gob Feed

This led to the natural development of the gob-feed process instead of the suction-feed Owens process. While the ultimate development of the gob feeder moved eastward at the same time, western inventors produced gob feeders which were successful and at least one of the plants still uses feeders that are a refinement of the original feeder which was conceived several years after the War period.

Many improvements were made in the blowing machines which received the gob of molten glass from the feeder and converted it into a bottle or jar. One of the first successful automatic machines for this purpose was designed by a man named Mackin, who did not live to see his invention developed commercially. Nearly all of the bottle machines of this type in use today make use of some of the ideas of this pioneer in the glass art.

The process of annealing glass by electricity was conceived and reduced to practice in one of the plants of the Illinois Pacific Coast Co. This method of annealing, due to the uniformly good results obtained, has become quite widespread. In connection with this development, it is worth noting that the engineer on the West Coast is not hampered by the high cost of electricity should he find its use desirable in operating his equipment.

Probably due to the availability of petroleum and lack of coal, the furnace designer on the Coast produced melting furnaces which were much more efficient than those found in the East. This was particularly true until the past few years, when eastern designers began a more intensive study of their problem. Natural gas has now replaced fuel oil, to the delight and profit of all the western plants that are now operating.

With the one exception of sand, Pacific Coast plants have been quite fortunate in having native raw materials for the production of glass. Until a short time ago, all of the sand used for glassmaking was imported from Belgium. The prohibitive import duty imposed by the last Tariff Act made it imperative that local manufacturers find some substitute for foreign sand. Finally, a low-grade sand was found which was amenable to a chemical treatment so that the final product, although more costly than middle western and eastern sand, could be brought within the limits of the necessarily rigid specifications required in a glass sand.

Soda ash, which constitutes one of the principal ingredients of the glass batch, is readily obtainable from several sources. By far the largest tonnage is produced from the brines of Owens Lake, in southern California. Limestone is found in many places and, fortunately, is of a high degree of purity. Both the pure calcium carbonate and dolomite are available. Feldspar, borax, and the minor components of glass are either found in the natural state or manufactured and are all readily available.

At the present time clays suitable for glass refractories are not available. This condition has made necessary the importation of foreign clays, most of which come from Germany. Foreign clays are imported as a matter of economy, since it is cheaper to haul by water from Germany than it is to ship from the United States clay deposits by rail. One California concern, however, is manufacturing an excellent synthetic refractory.

Production Costs Higher

Coast production costs are higher than in other sections of the country, due principally to the short-run factor previously discussed and to higher raw-material and labor costs. Fuel costs, however, are lower.

From an economic viewpoint the western glass industry is in fair shape, although improvement in automatic machines has stepped up possible production beyond the capacity of the territory to absorb the output. From unofficial estimated figures, it would appear that the potential output of the combined West Coast plants is about 2,340,000 gross per year, while the annual consumption is estimated at 1,660,000 gross. This condition, with consequent idle equipment, naturally is very undesirable. But while it would be a mistake to say that the current depression has not affected us, at the same time it is interesting to note that the glass industry on the Coast does not seem to have suffered as much as many others.

Alkaline Lake Brines Supply Western Soda Producers

By W. HIRSCHKIND
Vice-President in Charge of Research
Great Western Electro-Chemical Co.
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THERE ARE, in California and some of the adjoining states, a number of lakes carrying in solution carbonate and bicarbonate, together with other alkali salts such as chloride, sulphate and borate of both sodium and potassium, with the sodium usually the preponderant metal. These lakes were visited and sampled in the latter part of the last century and we find the first comprehensive description in the U. S. Geological Survey publications of I. D. Russell (U. S. Geol. Survey Mono. No. 11) and T. M. Chatard (U. S. Geol. Survey Bull. No. 60, 1890).

In southeastern Oregon there are two alkali-bearing lakes, Summer Lake and Albert Lake, which have been sampled by Russell (*loc. cit.*) in 1882 and later by H. T. Biddle (*Am. Jour. Sci.*, 3d ser., Vol. 35) in 1887. Analysis of the brine revealed that it contains a comparatively lower sulphate content than other lakes, but owing to great dilution and to the remoteness from transportation, the two lakes have never been commercially exploited.

Two soda lakes are located in the Carson Desert about two miles northeast of Ragtown, Nev., distinguished as Little Lake and Big Lake. They were sampled as early as 1868, and in 1887 soda was actually recovered there commercially. T. M. Chatard (*loc. cit.*), who visited the lakes at that time, described the operations in some detail.

Mono Lake, in Mono County, Calif., best known from Mark Twain's book, was visited and sampled by Russell in 1882 and described by him, and again later by Chatard, who actually experimented with solar evaporation of the brine during his stay at Owens Lake. The lake was never exploited commercially owing to its great dilution, short evaporating season, and remoteness from transportation.

Owens Lake Most Important

By far the most important source of natural soda was found at Owens Lake, in Inyo County, Calif., visited and described first in the reports of Lieut. Birnie and Dr. Oscar Loew (U. S. Geol. Survey, West 100th Merid., 1876) in 1876. T. M. Chatard (*loc. cit.*) spent some considerable time during the summers of 1886 and 1887 at the lake, after the commercial workings had already begun.

Searles Lake, San Bernardino County, Calif., was discovered by John W. Searles in 1862 and later located by Searles and Skillings in 1873 as a borax deposit.

Finally, there exists a deposit of solid natural soda at Bay Adair, a few miles north of the Gulf of Lower California, in the State of Sonora, Mex., which is reputed to have been worked at various times.

Natural Soda Origin

A number of theories exist about the formation of natural sodium carbonate. Chatard held the opinion that it is formed directly by the action of air, water, and CO_2 on volcanic rock, leached out and carried by the rivers into the lake beds, where it is concentrated. Hoyt S. Gale (U. S. Geol. Survey Bull. 580-L) calculates the quantity of saline concentrates contributed annually to Owens Lake by Owens River and even ventures an estimate of the age of the Owens Lake deposit from these figures. The total sodium content of Owens Lake has been determined as 60,000,000 tons, so that with an annual contribution of 17,000 tons, this represents 3,500 years of accumulation. Others, among them A. H. Hooker, argue that while chlorides and sulphates might be accumulated in this manner, natural soda is formed secondarily from sodium sulphate by the action of sulphur bacteria. This theory undoubtedly has some merit, as we find in nearly all natural soda lakes considerable organic life and sulphides. The clay from lake bottoms and shores also contains substantial quantities of hydrogen sulphide.

Lengthy speculations and discussions regarding the composition of crystallized natural soda engaged the early authors. This has been fully cleared up at present, largely by the phase-rule work of F. A. Freeth on the system Na_2—CO_3—NaCl—H_2O. At atmospheric temperatures the principal solid in equilibrium with solutions of carbonate and bicarbonate in the presence of other alkali salts is sodium sesqui-carbonate ($Na_2CO_3 NaHCO_3 2H_2O$), the mineral trona or urao. This material therefore is justly called natural soda. Up to the point where the bicarbonate content of the brine is used up, sesqui-carbonate crystallizes out, after which both deca-hydrate and mono-hydrate can be formed. Sodium carbonate deca-hydrate can form at lower temperatures (from 15 deg. to the freezing point), even in presence of bicarbonate.

As already mentioned, Summer and Albert Lakes in Oregon, as well as Mono Lake in California, have never been worked commercially. Commercial operations were carried on at the soda lakes near Ragtown, Nev., in the early 80's, as described by Chatard, who visited the lakes in 1887. In the so-called Big Lake, the brine was allowed to evaporate in solar ponds up to the crystallizing point, whereupon it was transferred to other solar vats, where the crystallization of trona took place. The crystal layer was drained, taken up by hand, and converted into soda ash by calcining in reverberatory furnaces. The operations on the so-called Little Lake seem to have been different, owing to a different composition of the brine, which seemed to be relatively free from sulphate. Here a crystallization of deca-hydrate was effected in winter, and the salt harvested and stored; at the approach of the warmer weather it was exposed to atmospheric drying. As much as 700 tons of sodium carbonate was produced annually at the two lakes, but the operations did not survive very long.

At Owens Lake the industry was started about 1885 and, despite its many trials, it is still in existence today. During 1885 the Carson & Colorado R.R., a narrow-gage road running from Reno, Nev., to Keeler, on Owens Lake, was completed as the first unit of a proposed road toward the Colorado River. The purpose was to accommodate the mines in the Keeler and Darwin territory. Unfortunately, the biggest mine in the region, the Cerro Gordo, was shut down before the railroad was completed.

First Operations at Owens Lake

A mineral surveyor of Virginia City, Nev., C. F. S. Wrinkle by name, interested D. O. Mills, the well-known financier of the Comstock days and owner of the Carson & Colorado R.R., in a soda venture on Owens Lake as a means of securing freight traffic for his line. Thus the first company to recover soda ash from Owens Lake, the Inyo Development Co., was founded. Owens Lake in the early 80's was an impressive body of water, covering approximately 100 square miles. The sodium carbonate concentration ran between 3 and 4 per cent, with approximately 0.7 per cent present as bicarbonate. Wrinkle, who probably had knowledge of the earlier workings at Ragtown, adopted a similar process. The brine was first concentrated in

large solar ponds to an alkali content of approximately 10 per cent (as sodium carbonate). It was then transferred to the crystallizing vats, where, on further solar evaporation, sodium sesqui-carbonate or trona crystallized out. This was continued until the bicarbonate content of the brine was used up, whereupon the mother liquor was returned to the lake and replaced with freshly concentrated brine.

It was attempted to precipitate the layer of trona approximately 2 in. thick so that it could readily be taken out by hand. After a crude washing operation this material was calcined in reverberatory furnaces, yielding a low-grade soda ash containing about 95 per cent sodium carbonate. The operation had to be carried out only during the warmer part of the year, because in winter the deca-hydrates of both sodium carbonate and sodium sulphate crystallized together, making the production of even an impure soda ash impossible. The calcining of trona seems to have presented considerable difficulty, finally being solved by heating the trona in round brick furnaces with direct flames, thereby converting it into sodium carbonate, melting the latter and discharging it from the furnace in molten form. After solidification the molten ash was ground and shipped to the markets in San Francisco and the Bay region. This soda ash had a much higher density than the standard ash, but found an outlet in the manufacture of glass on the coast.

It is interesting to note that the natural alkali industry at Owens Lake began at about the time when the Solvay process was brought to America, the Syracuse plant of the Solvay Process Co. having been started in 1881. The Inyo Development Co. operated continuously until 1920, when the desiccation of Owens Lake brine, caused by the diversion of the Owens River into the Los Angeles aqueduct, precipitated all of the trona in the lake itself and rendered the process inapplicable.

Process Improvements Introduced

About 1912 a new company, engaged in soda ash recovery, was formed on Owens Lake by Noah Wrinkle, the then superintendent of the Inyo Development Co. and son of the founder of this concern. Realizing that the trona crystallizing process permitted the recovery of only one-third of the sodium carbonate content of the lake brine, and that only in form of an impure soda ash, he attempted the Solvay practice of carbonating the brine and recovering sodium bicarbonate, converting the latter into soda ash by calcining. The advantage was that he could recover 60 to 70 per cent of the sodium carbonate content of the brine, as against 30 per cent possible in the trona crystallizing process. Moreover, by washing the precipitated bicarbonate, he could produce a much higher grade material.

The new venture, which was independent of the Inyo Development Co., built its plant a few miles south of Keeler and operated under the name of Natural Soda Products Co. The first unit of the plant consisted of a lime kiln, a few wooden carbonating towers, centrifuges, and a furnace similar to that used for melting trona. Carbonic acid gas was produced in the lime kiln where dolomitic limestone from the near-by Inyo range was burned with coke. The kiln gas was passed through the carbonating towers, the precipitated sodium bicarbonate centrifuged, washed, and then calcined to soda ash in a so-called melting furnace. The carbonic acid gas liberated during the calcining process was allowed to go to waste with the combustion gases. The soda ash produced had the same characteristics as the product of the Inyo Development Co., but was of higher purity, running 97 to 98 per cent sodium carbonate.

Subsequently the centrifuges were replaced by Oliver filters, which was, incidentally, the pioneer installation of Oliver filters in the chemical industry. The manufacturing of light soda ash by calcining in externally fired rotary kilns similar to those used in the ammonia-soda process was adopted later. This installation permitted a recovery of some of the CO_2 used for carbonating, but the light ash was of gray color, due to organic matter from the lake brine which was precipitated with the bicarbonate and charred during the calcining process. The organic matter is present in the lake brine as organic sodium salts and not as colloids, and its removal from the brine is extremely difficult.

Owing to the heavy demand for soda ash and the high price of this commodity caused by the War, the Natural Soda Products Co. was able to expand considerably in subsequent years.

This heavy demand for soda ash and the high-war-time prices attracted other manufacturers to Owens Lake. In the early part of 1917 a group, in which the Great Western Electro-Chemical Co. participated, decided to build a soda-ash plant on the southwestern shore of Owens Lake, a location giving better transportation facilities than the eastern side. The plant of the California Alkali Co. was erected in 1917 at a point called Cartago, and was completed in record time the same year. The equipment consisted of solar ponds for evaporation of the lake brine, lime kilns, wooden carbonating columns for carbonization, and externally fired rotary calciners of the type used in the ammonia-soda industry. Both light and dense soda ash were produced with a purity comparable to Solvay ash, although it was discolored by charred organic matter.

Up to 1919 the company enjoyed comparative prosperity, selling its entire output on the Pacific Coast and in Japan. When, after the Armistice, the demand sank much below normal levels, the plant had to be shut down for several years. At about 1923 the soda-ash market recovered again and the California Alkali Co. resumed operations. A merger was effected in 1924 with another group and the operations were continued under the name of Inyo Chemical Co. From that time until the recent depression, both Natural Soda Products Co. and Inyo Chemical Co. operated at considerable capacities, although not always profitably.

Owens River Diverted

The city of Los Angeles was able to divert the entire flow of Owens River into the aqueduct during 1917, and has continued to do so ever since. Consequently, the lake receded constantly and the brine became saturated with trona during the fall of 1920. During the winter of 1920-21, very substantial quantities of the sodium carbonate content of the brine, together with sodium sulphate, were precipitated and would not go into solution again during the following spring. During the summer of 1922 trona was precipitated until the entire bicarbonate content was removed and the brine finally reached saturation with sodium chloride and sodium sulphate. Subsequently these salts, together with sodium carbonate, mono- and deca-hydrate, were also precipitated and the lake reached a stationary condition consisting of a salt bed through which brine saturated with all constitutents circulated. This necessitated changes in the mode of operation on the part of both the Natural Soda Products Co. and the California Alkali Co. (Inyo Development Co. had discontinued operation in the fall of 1920). Natural Soda Products Co. obtained its raw material by leaching deposits on the shores of the lake, while the California Alkali Co. pumped equilibrium brine from the deeper part of the lake at a considerable distance.

In 1926 a Los Angeles group, attracted by the possibilities of manufacture of soda ash, built a plant at the northeast corner of Owens Lake, under the name of Pacific Alkali Co. This used a process of carbonating only partially, to the sesqui-carbonate stage, recovering this material and calcining it in a furnace of the Herreshoff type to reach temperatures high enough to burn out the organic matter, thereby producing a white product. The material manufactured in this manner is a dense ash. The plant has operated only intermittently and at small capacity.

Caustic Soda Production

Still during the War, in 1917, a caustic-soda plant was erected at the northwest part of Owens Lake by a group of Denver capitalists, operating under the name of Denver Chemical

Co. The equipment came from an abandoned caustic-soda plant at Green River, Wyo. It was erected but never operated. The site and plant were later purchased by a group of Boston capitalists, who completely rebuilt the plant and operated for a short time, under the name of Clark Chemical Co., manufacturing caustic soda. The economies of this operation were such, however, that it could not survive and the plant was closed after a short period.

Caustic soda was manufactured from soda ash, as well as from crude Owens Lake natural soda, by the Great Western-Electro Chemical Co., which built a unit for causticizing soda ash in 1924 at its Pittsburg plant. A second unit for causticizing soda ash was installed at the plant of the Stauffer Chemical Co. at Los Angels during 1928.

In 1908 the Searles Lake deposit discovered by J. W. Searles was relocated by E. E. Dolbear and several others for the purpose of establishing a soda-ash industry there. A contesting party, said to be from the Solvay Process Co., also was on the ground and a pitched battle was once fought by the claimants. The Dolbear party won out, however, forming subsequently the California Trona Co.

As the name indicates, the recovery of soda was the objective, although none was ever produced up to 1912, when a joint press bulletin issued by the U. S. Geological Survey and the Bureau of Soils focussed nation-wide attention on Searles Lake as a source of potash. The California Trona Co. and its successor, the American Trona Corp., and later the American Potash & Chemical Corp., began with the erection of a potash and borax plant which has recently been expanded to very large proportions. Sodium carbonate, which is present in the Searles Lake brine in about the same quantity as muriate of potash, has not been recovered as yet, but attempts are being made in this direction. During the process of evaporation for potash recovery, the carbonate is separated with sulphate as burkeite ($2Na_2SO_4 \cdot Na_2CO_3$), a new double salt discovered by Mr. Burke, of the American Potash & Chemical Corp. Whether the Burkeite will be disposed of as such, or whether a separation of its two constituents will be effected, will depend largely on market conditions.

The late F. M. (Borax) Smith, who spent the last 30 years of his life in an effort to get back into the borax industry which he once founded, located a plant on Searles Lake for the purpose of manufacturing borax. The process for borax recovery worked out by Hellmers consisted in carbonating Searles Lake brine, separating the bicarbonate, and allowing the borax to crystallize from the mother liquors. Owing to the unfavorable condition of the borax market, the plant could not operate on borax alone. By calcining the precipitated bicarbonate a low-grade soda ash is produced which today forms the main product of the operation carried on by the West End Chemical Co.

The market for soda ash on the Pacific Coast and adjoining states is normally about 100,000 tons per year, although at present, owing to the depression, it is probably considerably less. This market is divided among four companies actually manufacturing, and one looming as a potential manufacturer. The entire tonnage is hardly large enough for economical operation of even a small unit of an ammonia-soda plant. This answers the frequent inquiries about possibilities of an ammonia-soda plant on the salt beds of San Francisco Bay. Even if the consumption should grow considerably, it is doubtful whether such an operation could compete in costs with the recovery of soda ash from natural alkaline lakes.

Soap for Half The World From Pacific Coast

By CHESTER L. BAKER
Chief Chemist
Philadelphia Quartz Co. of California, Ltd.

FIFTEEN YEARS AGO a nationally known soap manufacturer decided to establish a branch plant in California. The parent plant, also somewhat of a pioneer, had been located in a meat packing city in the Middle West where an abundant supply of cheap tallow for raw material and a rapidly growing agricultural population for consumers had supplied the economic foundation for success. As its business outgrew national bounds it was but natural that it should select a second location on the Pacific Coast where cheap water transportation could carry its product to the countries containing 60 per cent of the world's people and where the same cheap water transportation could bring it the ever-increasing number of raw materials needed. Time has proved the wisdom of the choice, for the company has since expanded its plant twice and increased its production many fold.

Two other national manufacturers who have since established plants on the Pacific Coast, together with expanded local organizations, now constitute one of the most important industries. According to the Bureau of the Census, there were 40 plants operating in 1929, whose principal product was soap. Their production for that year is valued at $18,933,895. More complete details are given in Table I. An independent source reports that in 1930, some 72 plants produced soap as a primary or secondary product in California, Oregon, and Washington, with a value of $21,000,000.

One of the principal reasons for this growth is to be found in the availability of abundant raw materials at low prices. Tallow, the old standby of the

Pacific Coast Plant of Procter & Gamble Co., at Long Beach, Calif.

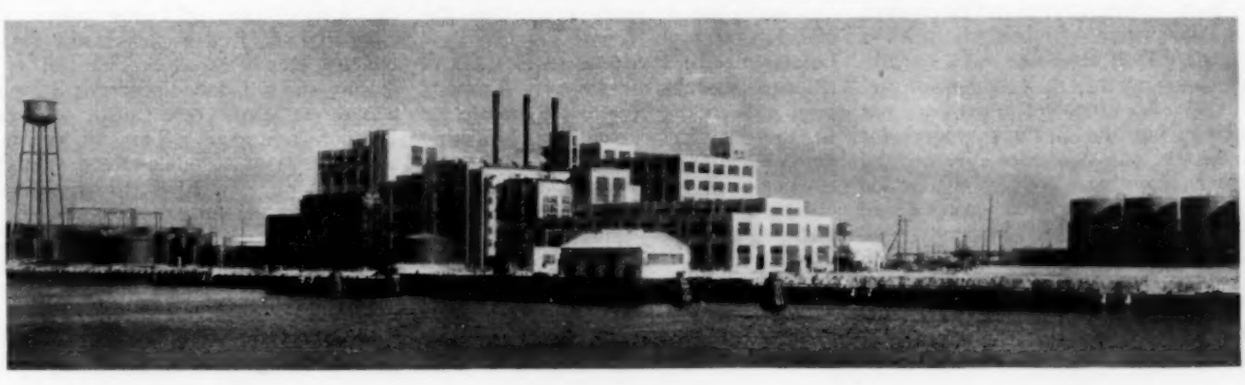

Table 1—Soap on the Pacific Coast

Biennial Census of Manufacturers, 1929

Sales (Shipments or Deliveries) of Soap and Production and Consumption of Materials Used in Soap Manufacture, for California, Oregon, and Washington.

Material	No. Establishments	Pounds	Value
Total, all kinds, Calif., Ore., Wash.	40*	195,984,600	$18,933,895
Toilet soap, total, for Ore. and Wash. (none reported from Calif.)	4	157,173	16,643
Yellow laundry soap:			
Calif.	12	7,249,245	443,724
Ore. and Wash.	5	3,380,160	184,911
Soap chips, total, Calif., Ore. and Wash.	14	13,387,979	1,418,161
Other hard soaps:			
Calif. and Ore.	6	4,701,827	210,009
Wash.	3	512,000	33,873
Soap powder:			
Calif.	13	8,945,863	648,268
Ore. and Wash.	5	1,291,065	67,378
Liquid soap:			
Calif.	18	2,282,238	156,749
Ore. and Wash.	9	312,526	27,947
Paste soap, total, Calif., Ore. and Wash.	9	982,274	91,961
Soft soap, total, for Calif. and Wash. (none reported from Ore.)	11	808,947	71,171
Soap stock, total, Calif. and Wash. (none reported from Ore.)	7	212,248	21,557
Other soap, total, Calif., Ore. and Wash.	33	151,761,055	15,541,543
Animal fats, tallow, grease, red oil, fish oil, etc., Calif.	..	29,186,935	2,217,197
Caustic Soda:			
Calif. and Wash.	4	26,366	1,437,607
Soda ash: Calif.	4	80,938	1,688,443

*The number of establishments engaged primarily in the manufacture of soap, not including the number reporting soap as a secondary product. The items for the several kinds of soap, however, include the number of establishments reporting soap as a secondary product.

soap man, finds its source in the numerous range cattle. The 1929 production for the three states is given by the Bureau of the Census as 46,232,175 lb.

The larger part of the copra brought into this country from the Philippines and South Sea Islands is crushed in Pacific Coast plants. Most of the oil thus obtained is used in soap manufacture in this country. This valuable oil has specific properties of its own and does not compete with domestic fats. It is much prized by soap makers generally for its white color and the fact that its soap gives a very abundant lather. From it is made the only soap that can be used with any degree of success in salt water.

In former years, large quantities of soya bean oil were imported into this country from Northern China, and comprised an important soap material. Recent civil strife plus a high tariff has cut off most of this supply. This loss has been offset, however, by sesame seed, from which a high grade of oil is obtained. This seed was first brought into this country in large quantities during 1930. Complete figures are not available, but the customs reports for the ports of San Francisco, Seattle, and Los Angeles give a total of 49,854,633 lb. of combined sesame and perilla seed as being brought in during 1930. Similar figures for 1929 show only 15,607,158 lb.

Whale oil is rendered by three Pacific Coast companies. During the season 1929-30, two of these operated, producing 17,700,000 lb. of oil. This is used almost exclusively in soap manufacture. The comparatively recent discovery that fish oil can be hardened and deodorized by hydrogenation has raised it to sixth place in the rank of industrial oils and fats for soap making. The total domestic production of fish oil for the season 1929-30 was 166,378,000 lb. The Pacific Coast, including British Columbia, contributed 95,532,000 lb. About 78 per cent of this was used for soap.

The acreage of cotton in California has been increasing rapidly during the last five years. All of the seed produced is crushed locally. The 1930 crop yield was 40,200,000 lb. of oil.

It is generally believed that soap makers have an inexhaustible supply of soda ash in Searles and Owens lakes. Four plants are now recovering this alkali from the brines of these California beds. It is estimated that they are equipped to produce 75,000 tons annually, although this figure has not yet been reached. A portion of their production is used directly in soap manufacture. Another portion is converted into caustic soda by the lime causticization process and part of this finds its way into soap. Accurate figures are not available for the exact quantities of natural sodas finding their way into soap, but the tonnage is known to be large. There are four caustic-soda plants on the Pacific Coast. Three of these are now operating and supply a considerable part of the caustic soda used in soap manufacture.

Silicate of soda contributes greatly to the detergent or cleaning power of laundry soaps and constitutes an important component. The four plants located on the Pacific Coast have an estimated capacity equal to twice the present market demand. Their construction has been made necessary by the relatively short freight haul that the price of their product will permit.

The Pacific Coast soap industry is thus in a healthy position and its future, with expanding markets both at home and in the Far East, should be well assured.

Fortunes and Misfortunes Of Western Chlorine

By W. HIRSCHKIND

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THE CHLORINE INDUSTRY on the Pacific Coast had its beginning back in the early part of 1916, when the Great Western Electro-Chemical Co. built the first unit of its plant at Pittsburg, Calif. The impetus for this venture was given by one of the large public utility corporations on the Coast, the Great Western Power Co., anxious to utilize some of its excess hydro-electric power for industrial purposes. That the electrochemical industry ranks among the largest users of electric energy was pointed out to the power company in connection with a relatively large market for caustic soda on the Pacific Coast. The outlook for disposal of chlorine was not nearly as good, but it was hoped that the chlorine problem could be solved as time went on and a market for various chlorine products developed. A lonely pulp mill in the Northwest loomed up as the main consumer for bleaching powder in 1916.

The plant was located at Pittsburg, Calif., at the junction of the Sacramento and San Joaquin rivers. The opening of a new industrial territory in that region, as well as the availability of a good supply of fresh water, had much to do with the choice of location. In fact, this was considered to outweigh the advantage of locating near the source of the main raw material on the salt beds of San Francisco Bay. Time has proved the reasoning fallacious, since now both rivers, during a large part of the year, do not carry fresh water but salt water. The first unit of the plant had a capacity of 12 tons of caustic and 10 tons of chlorine, the latter to be converted entirely into bleaching powder. Salt, the main raw material, came from San Francisco Bay, while power was furnished by the Great Western Power Co., which, as mentioned above, was the main sponsor for the plant.

The electrolysis was carried out in an installation consisting of four banks of Allen-Moore cells for which the company acquired the exclusive rights on the Pacific Coast. The cell is a diaphragm cell and discharges a liquor containing 10 per cent caustic soda and 16 per cent salt. This liquor was evaporated in a double-effect Zaremba evaporator installation to 48-50 per cent. Part of the caustic soda output was shipped as 48-50 per cent liquor, while the rest was solidified in the customary caustic pots. The manufacture of bleaching powder from chlorine was carried on in a chamber installation similar to the one used by the Dow

Plants of Colgate-Palmolive-Peet Co. (Left) and Philadelphia Quartz Co., (Center) at Berkeley, Calif.

Chemical Co., of Midland, Mich. These chambers had no artificial refrigeration and proved to be inadequate during the warmer season of the year.

The market for bleaching powder on the Coast was not sufficient to take the entire output but it was possible during the War to export a considerable quantity, as well as to ship it into territories not usually considered tributary to the Pacific Coast. Under the stimulus of a large caustic-soda market and the then prevailing high war-time prices, efforts were directed toward the development of other chlorine products which would make it possible to increase the caustic-soda production.

In 1917 plants for the manufacture of liquid chlorine, sulphur chloride, carbon tetrachloride, and potassium chlorate were erected and put into operation. Of these developments the manufacture of liquid chlorine alone survived the armistice in 1918. The bleach chamber installation by the Dow system, which proved rather inadequate at the beginning, gave out entirely during 1919 and had to be replaced completely in 1920. The system chosen was that of the Bleach Process Co. with a capacity of about 1,000 tons of bleaching powder per month. This plant is still in operation today, although at very small capacity.

The manufacture of liquid chlorine made a slow, although gradual, growth. The system for liquefaction installed was one adopted generally at that time and consisted of compression of the gas to 100 lb. and subsequent cooling with brine from an ammonia refrigerating plant. The system is still in use today, although with a different type of compressor.

After 1918 the market for bleaching powder, which could be manufactured at a very satisfactory quality in the new installation, became smaller and smaller and new outlets for chlorine had to be found, if the caustic production was to be maintained.

In 1921 the company entered the manufacture of zinc chloride, which during the War had been adopted by many railroad companies as a substitute for creosote in treating railroad ties. This use continued for a considerable time after the War, although under gradually declining prices. The company developed its own process, consisting of treating metallic zinc with chlorine gas and water, which furnished directly a 50 per cent solution. This material was evaporated to 70 per cent strength and shipped as such. As a further outlet for chlorine the company developed in 1921 a process for the manufacture of hydrochloric acid by treating coke with steam and chlorine. This process, which furnished a very satisfactory quality of acid, had the advantage over the one adopted by other electrolytic manufacturers of burning hydrogen with chlorine, in that it leaves the hydrogen available for other and more valuable purposes.

When in 1922 and subsequent years the zinc chloride price dropped to such low levels that the manufacture from metallic zinc became unprofitable, the company resorted to the manufacture of zinc chloride from zinc ores by roasting the ores and treating the calcine with hydrochloric acid. The zinc chloride solution made by this process was of considerably lower strength and purity than the one made from metallic zinc and necessitated a system of evaporation and purification. Nevertheless, it enabled the company to continue in the zinc chloride business until 1925.

At that time the use of liquid chlorine in the sanitary field, and particularly the use of bleaching powder by the pulp and paper industry of the Pacific Northwest, had grown to proportions such as to furnish not only a satisfactory outlet for the entire chlorine production but also necessitated considerable and rapid increases in the years to come. However, the latter did not prove to be an unmixed blessing, since the pulp and paper industry began at that time to change from the use of bleaching powder to the use of liquid chlorine, preparing its own bleach liquor at the mills from chlorine and lime. This change necessitated a rapid increase in facilities for manufacture and transportation of liquid chlorine, leaving at the same time the comparatively new installation for manufacture of bleaching powder standing idle. During the years 1924 and 1928 the plant capacity for manufacture of chlorine was increased to about 35 tons per day, which, toward the end of the period, went nearly entirely to liquid chlorine.

It was natural enough that the unprecedented growth of the pulp and paper industry in the Pacific Northwest, with corresponding increases in the chlorine consumption, should attract other chlorine manufacturers to the Pacific Coast. Attracted by low rates for hydro-electric power in the State of Washington, two eastern chlorine manufacturers, the Hooker Electrochemical Co., of Niagara Falls and New York, and the Pennsylvania Salt Manufacturing Co., of Philadelphia, investigated the chlorine market in the Pacific Northwest and both decided during 1928 to build plants at Tacoma, Wash.

The plant of the Hooker Electrochemical Co., which was put into operation in February, 1929, combines the most modern trend in plant design and equipment and was described in considerable detail in *Chem. & Met.*, July, 1931, pp. 380-3.

The Pennsylvania Salt Manufacturing Co. built its plant during 1929 and began to operate during 1930 under the name of the Tacoma Electrochemical Co. The plant is smaller than the Hooker plant, having a capacity of about 9 tons of chlorine and a corresponding quantity of caustic soda. The electrolysis is carried out in installation of Gibbs or Vorce cells, which are used in the eastern plants of the Pennsylvania Salt Manufacturing Co. as well as other electrolytic plants with considerable success. The system of caustic evaporation and chlorine liquefaction also is the most modern available and very similar to the installation at the Hooker plant.

The chlorine industry on the Pacific Coast presents, therefore, a very satisfactory aspect from the standpoint of the pulp and paper manufacturer. From the standpoint of the chlorine manufacturer it suffers from the ailment of many industries today, over-expansion.

Pulp and Paper Industry Makes Progress in Northwest

By W. L. BEUSCHLEIN

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MANY factors favorable to the pulp and paper industry are presented by the Pacific slope. This is evidenced by the rapid growth in the last decade. A survey of the yearly pulp production given in Table I shows that in an interval of nine years an increase of 250 per cent has been made. Some of this pulp is converted into paper and board on the Coast, although imports and exports also are increasing. During the year 1930, new sulphite mills and major improvements were completed at an expenditure of $30,000,000. The total daily pulp capacity increased from 4,660 tons in 1929 to 5,180 tons in 1930, although actual production was but 54 per cent of the rated capacity in the latter year. The majority of this pulp was sold in the eastern states and in competition with the established trade. An investigation of the factors favoring the western development may be of interest.

Timbered regions on the Coast are clearly defined by the topography of the country and to a lesser degree by the ease of exploitation. This timber land reaches from Alaska to northern California and west of the Cascade Range to the Pacific Ocean, embracing in Oregon and Washington alone some trillion board feet of merchantable timber. Species predominating in certain localities are the douglas fir, western hemlock, sitka spruce, and western cedar. In northern British Columbia and Alaska the majority of the timber is spruce and hemlock. The greatest single area of timber is to be found in the Olympic peninsula, so that the Puget Sound region with its sheltered water hauls has been considered ideal for production of pulp woods. Other districts fed by logging streams and of importance are the Grays Harbor, Williamette River, Oregon coast, British Columbia, Idaho-eastern Washington-Oregon, and that of northern California. Yellow pine predominates in the Idaho-eastern Washington-Oregon district, while sugar pine, redwood, and white fir largely constitute the stands in northern California. In the entire region, natural reforestation proceeds at a rate in excess of the demand for pulp wood, thus providing a perpetual supply.

Grades of pulp produced from western woods are now considered to be equal to those obtained from similar species elsewhere, although some years ago this was debatable. Woods are available for the production of ground wood, sulphite, sulphate, and soda pulps.

An important factor in the development of the industry has been the low cost of pulp wood. Due to the poor merchandising of hemlock as lumber, loggers estimate it does not pay to bring in saw-logs under 16 in. in diameter, but, in combination for pulp wood, these small tops at low prices represent a profit. In general, log loading and handling equipment has been mechanically developed so that a four-man crew regularly loads 50 cars of logs per shift. When it is remembered that logging operations on the Coast are not seasonal but continue throughout the year, and that short water hauls constitute the major method of transportation, the cost of pulp wood at figures far below those of eastern mills is not unexpected.

There is now being developed a major industry which will have as its function the supplying of pulp wood to the pulp and paper mills. The nucleus of this industry is originating around the utilization of sawmill waste. The U. S. Department of Commerce Census for 1928 shows that in the State of Washington 31,066 cords of sawmill waste was used, or about 75 per cent of the total mill waste used in the entire United States. During 1929, this consumption is estimated to have increased 30 per cent on the Coast and 23 per cent for all the states. Sawmills are regularly delivering slabs and chips to pulp-mill storage bins, and hogged fuel for process steam. The refuse burner is no longer representing an annual repair bill, but in its place the pulp industry is finding a dependable source of raw material. The linkage of sawmill with pulp mill represents an important economic phase in the exploitation of our forests. This combination has been responsible in no small measure for the price of pulp wood on the Coast being $7 per cord, as compared with $12 to $19 in Wisconsin, Maine, and New York. In similar manner, steam at many mills costs 18-22c. per 1,000 lb.

With few exceptions, western mills have been placed on tidewater in harbors capable of docking ocean-going vessels. Modern warehouse equipment such as monorails, conveyors, and cranes are used for transferring cargoes to and from ships. Due to the difference between rail and water rates, pulp on the Pacific may be laid down in New York by water at a transportation cost no greater than that by rail from many eastern inland mills. Vacuum drying of pulp is justified on the freight saved on the lower moisture-content product shipped. As an example of the effect of low transportation and pulp-wood costs, there are instances of western pulp meeting competition in Kalamazoo.

Pulping methods in the main are similar to those used elsewhere. With the advantages of building on past experience and recent developments, many new western plants are examples of the latest improvements. Research and technical control have been fully recognized. Western installations plan on long-time operation, with the result that labor and operating costs are reduced, although first costs are high.

The United States consumed 12,160,000 tons of paper in 1930, of which 19 per cent, or 2,328,000 tons, was imported, and with the per capita consumption increasing, the future development of the western industry is at least optimistic. The growing demand for paper products in the Far East may be expected to draw its quota from the Pacific Coast. Diversification of products has been an important factor in marketing western pulp. The manufacture of insulating board, fiberboard, box board, and fruit wrappings has done much in developing and extending local consumption. Close cooperation between western sulphite mills and eastern chemical manufacturers has interlocked the industries to such an extent that wood cellulose is finding a ready market in the preparation of viscose and rayon. As a raw material in the manufacture of nitrocellulose, the wooded slopes of the Pacific assume importance.

Table I—Woodpulp Production, Pacific Coast States and British Columbia

(Tons of 2,000 Lb.)

	1921 Tons	1923 Tons	1924 Tons	1925 Tons	1926 Tons	1927 Tons	1928 Tons	1929 Tons	1930* Tons
Washington	95,161	136,943	159,539	161,858	199,164	268,349	349,107	523,948	475,000
Oregon and California	124,494	162,653	149,894	160,736	178,841	200,869	213,407	256,546	225,000
British Columbia	164,746	217,076	216,243	230,733	259,504	296,253	310,961	304,619	316,000
Total Pacific Coast	384,401	516,672	525,676	553,327	637,509	775,471	873,475	1,085,113	1,016,000

Source—United States figures from United States Department of Commerce, Bureau of Census; British Columbia figures from Department of Lands, Forest Branch; and Dominion Bureau of Statistics.

*Estimated on production of previous year, adjusted to include new tonnage beginning production in 1930 and general reduced operations in industry as a whole.

Pulp and Paper Capacities of Pacific Coast Mills

Principal grades manufactured and capacities in tons per 24-hour day on Dec. 31, 1930

Name of Mill	Location	Pulp					Paper						Remarks
		Mechanical	Unbleached Sulphite	Bleached Sulphite	Sulphate	Soda	News	Sulphites	Sulphates	Book	Board	Others	
British Columbia													
British Columbia Pulp & Paper Co.	Woodfibre	...	120	...	...	...	...	...	...	...	...	...	...
British Columbia Pulp & Paper Co.	Swanson Bay	...	...	...	...	...	...	...	...	...	...	...	Mill idle.
British Columbia Pulp & Paper Co.	Port Alice	...	...	100	...	...	...	...	...	...	...	...	...
Canadian Forest Products, Ltd.	Beaver Cove	...	...	...	...	...	...	...	...	...	...	...	Mill idle.
Pacific Mills, Ltd.	Ocean Falls	190	60	...	60	...	200	50	60	...	...	...	News, kraft, and sulphite wrapping, fruit wrap, tissues, etc.
Powell River Co., Ltd.	Powell River	500	150	...	...	...	650	...	...	...	...	...	Capacities upon completion of present program.
Sidney Roofing & Paper Co.	Victoria	10	...	...	...	...	...	...	...	...	25	...	Roofing and boards.
Vancouver Kraft Mills, Ltd.	Port Mellon	...	...	...	100	...	...	...	...	...	...	...	Construction temporarily suspended.
Westminster Paper Mills, Ltd.	New Westminster	...	...	...	...	...	...	20	...	...	...	...	Fruit wrap and tissues.
Washington													
Berkheimer Mfg. Co., J. E.	Tacoma	...	...	...	...	...	...	...	...	...	...	6	Rag roofing, etc.
Cascade Paper Co.	West Tacoma	...	...	...	...	25	...	...	...	50	...	...	Mill idle.
Columbia Paper Mills	Vancouver	30	110	...	...	...	...	110	...	...	...	...	All grades sulphite wrapping.
Crown Willamette Paper Co.	Camas	90	150	150	190	...	...	350	60	...	...	...	Bleached specialties and tissues.
Everett Pulp & Paper Co.	Everett	...	...	...	...	50	...	...	...	75	...	...	M. f. and s. c. book, railroad writing.
Fibreboard Products, Inc.	Port Angeles	30	50	...	...	...	...	...	...	...	75	...	Spruce and chip board.
Fibreboard Products, Inc.	Sumner	...	...	...	...	...	...	...	...	...	50	...	Chip and container board.
Grays Harbor Pulp & Paper Co.	Hoquiam	...	...	150	...	...	...	50	...	...	...	...	Bonds and writing.
Inland Empire Paper Co.	Millwood	80	35	...	...	...	110	...	...	...	...	...	News, poster, etc.
Longview Fibre Co.	Longview	20	...	...	120	...	...	...	135	...	...	...	Container board and m. g. wrapping.
National Paper Products Co.	Port Townsend	...	...	...	200	...	...	...	200	...	...	...	Container board and kraft liner.
Olympic Forest Products Co.	Port Angeles	...	...	150	...	...	...	...	...	...	...	...	...
Pacific Coast Paper Mills	Bellingham	...	...	...	...	...	...	15	...	...	...	...	Toilet tissues, etc.
Pacific Straw Paper & Board Co.	Longview	10	...	...	...	...	...	...	...	...	40	...	...
Rainier Pulp & Paper Co.	Shelton	...	...	170	...	...	...	...	...	...	...	...	...
Puget Sound Pulp & Timber Co., Fidalgo Division	Anacortes	...	65	...	...	...	...	...	...	...	...	...	...
Puget Sound Pulp & Timber Co.	Everett	...	...	175	...	...	...	...	...	...	...	...	...
Puget Sound Pulp & Timber Co., San Juan Division	Bellingham	...	90	...	...	...	...	...	...	...	...	...	...
Shaffer Box Co.	Tacoma	...	50	...	...	...	...	...	...	...	...	...	...
St. Regis Kraft Co.	Tacoma	...	...	...	160	...	...	...	...	...	...	...	...
Tumwater Paper Mills	Tumwater	20	...	...	...	...	...	40	...	...	...	...	Mill idle.
Wash. Pulp & Paper Corp.	Port Angeles	250	70	...	...	...	300	...	...	...	...	...	Newsprint.
Weyerhaeuser Timber Co.	Longview	...	...	150	...	...	...	...	...	...	...	...	Under construction.
Oregon													
Crown Willamette Paper Co.	Lebanon	...	30	...	...	...	...	30	...	...	...	...	Wrapping.
Crown Willamette Paper Co.	Oregon City	60	...	...	...	...	...	...	...	...	...	...	"East side groundwood mill" operated in connection with West Linn Mill.
Crown Willamette Paper Co.	West Linn	375	90	...	...	...	350	...	...	...	...	...	Newsprint.
Fir-Tex Insulating Board Co.	St. Helens	...	...	...	...	...	...	...	...	...	...	...	Wood fibre insulating board. Daily capacity 250,000 sq.ft.
Hawley Pulp & Paper Co.	Oregon City	150	85	...	...	...	120	85	...	...	...	...	News, sulphite wrapping, lightweight papers, etc.
Oregon Pulp & Paper Co.	Salem	...	...	110	...	...	...	110	...	...	...	...	Sulphite bonds, glassine, greaseproof.
St. Helens Pulp & Paper Co.	St. Helens	...	...	...	60	...	...	...	60	...	...	...	Wrapping-adding second machine.
Sitka Spruce Pulp & Paper Co.	Empire	...	50	...	...	...	...	...	...	...	...	...	...
Spaulding Pulp & Paper Co.	Newberg	...	75	...	...	...	...	...	...	...	...	...	...
Western Board Products Co.	Salem	...	...	...	...	...	...	...	...	...	...	8	Binder board.
California													
California Fruit Wrapping Mills	Pomona	...	...	...	...	...	...	20	...	...	...	...	Fruit wrap.
California-Oregon Paper Mills	Los Angeles	...	...	...	...	...	...	40	...	...	...	...	Sulphite and kraft wrapping.
Certain-teed Products Corp.	Richmond	...	...	...	...	...	...	...	...	...	...	38	Roofing and felts.
Crown Willamette Paper Co.	Floriston	15	35	...	...	...	...	45	...	...	...	...	Dismantled.
Fibreboard Products	Los Angeles	...	...	...	...	...	...	...	...	...	100	...	...
Fibreboard Products	Stockton	...	...	...	...	...	...	...	...	...	250	...	...
Fibreboard Products	Los Angeles	...	...	...	...	...	...	...	...	...	8	...	Binder board.
Fibreboard Products	Antioch	...	...	...	...	...	...	...	...	...	200	...	Container board, tag, etc.
Johns-Manville Corp.	Pittsburg	...	...	...	...	...	...	...	...	...	...	35	Asbestos paper.
Los Angeles Paper Mfg. Co.	Los Angeles	...	...	...	...	...	...	...	...	...	...	30	Roofing.
Paraffine Cos., Inc.	Oakland	...	...	...	...	...	...	...	...	...	...	100	Roofing and felts.
Pioneer Paper Co.	Los Angeles	...	...	...	...	...	...	...	...	...	...	75	Roofing and felts.
Colorado													
Colorado Pulp & Paper Co.	Denver	15	...	...	...	...	...	...	...	...	50	...	...
Total daily capacities		1845	1315	1155	790	75	1730	965	515	125	798	292	

Total pulp capacity — all grades 5,180
Total paper capacity — all grades 4,425

*Totals do not include 250,000 sq.ft. of insulating board.

Total Pacific Canadian capacity: pulp, 1,390 tons; paper, 1,005 tons.

Total Pacific United States capacity: pulp, 3,790 tons; paper, 3,420 tons.

Acknowledgment is made of previous publication in *Pacific Pulp and Paper Industry*, March 31, 1931.

Petroleum, Largest of Pacific Coast Industries

By JOHN FRANKLIN DODGE

Professor of Petroleum Engineering,
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Los Angeles, Calif.

THE Pacific Coast petroleum industry is centered almost wholly in southern and central California. These oil fields have been more productive than any other fields of equal area in the entire world, furnishing at present one-fourth of the output of the nation and one-fifth of that of the entire world. California's production to date is more than 3,000,000,000 bbl., with a value well in excess of that many dollars. These fields furnish the greater part of the gasoline, lubricants, and industrial fuel used on the western slopes of both North and South America and, in addition, large quantities of gasoline, kerosene, and diesel oil for export to Japan, China, and other parts of the Orient.

In normal times California oil companies employ directly 60,000 people, to whom they pay $125,000,000 annually and furnish indirect employment to 200,000 more in occupations dependent, more or less completely, on the oil industry for their existence. In addition, the industry purchases over $100,000,000 worth of supplies and equipment annually in normal times.

The economic situation of the industry today, while far from satisfactory, is by no means hopeless. Indeed, when one compares the situation existing today with that of six months ago, many cheering features can be noted.

Improved drilling and production technique, the discovery of an unusual number of flush fields, and unrestricted competitive drilling in many of these fields during the past decade had resulted, by the end of 1930, in an accumulation in storage of nearly 700,000,000 bbl. of crude and refined petroleum, a tremendous burden with which to enter a period of lessened demand, both because of the amount of capital invested and the hazard and expense of carrying and protecting such stocks.

The pipe-line and refining branches found themselves similarly overexpanded, and this condition extended into the marketing end of the business even to the establishment of an excess of retail distributing points, service stations, and sub-agencies. The struggle for gallonage among these stations and distributors brought on costly gasoline wars, with resulting low realization by refiners, cuts in the price of crude, and further distress all along the line.

Into this chaotic situation two factors, long discussed but dismissed by most operators as ideal in theory but impractical of application, have been injected and made to work. These factors are cooperative restriction of production in old areas and unit operation agreements in the development of new pools. The situation required heroic and even drastic measures and it is to the everlasting credit of the leaders of the oil industry in general that once they realized this situation, excellent cooperation was obtained on the part of the majority of the operators. The improvements to be noted today are largely the result of their actions.

A survey by properly constituted boards determined the quantity of oil required to supply the needs of the refining branch of the industry, quotas were assigned to each state and district, and the district quotas subdivided and assigned by production umpires to each individual operator. Such a scheme could not be expected to function perfectly, but it has been so successful that not only has the mounting storage total been halted but the tide has been turned and current figures show that storage was actually decreased by 16,000,000 bbl. during August, 1931.

The importance of the petroleum industry in the every-day life of the nation can, perhaps, best be brought home to the individual by imagining the sudden withdrawal of all petroleum products from accustomed uses and visualizing, if possible, the results of such a withdrawal. Our locomotives, steamships, automobiles, and airplanes would be anchored in place, useless and immobile. The wheels of industry in general would come to a grinding stop, literally as well as figuratively speaking.

According to figures of the American Petroleum Institute, something like eleven billion dollars is invested in the petroleum industry, roughly divided as follows: Production, $5,000,000,000; refineries, $3,000,000,000; marketing, $1,200,000,000; pipe lines, $1,000,000,000; tank cars, $300,000,000; tank steamers, $500,000,000.

The development of the industry has taken place within a single lifetime and the greatest part of this growth has occurred in the last two decades. In fact, the total investment in the industry in 1909 was only $800,000,000, less than the present investment in pipe lines alone.

Probably the greatest threat to the security of the industry lay in the Kettleman Hills field, an area in the San Joaquin Valley of California. Enormously productive of oil of a gravity hitherto unequaled and yielding very high gasoline percentages, this field—if its development had not been restricted—would have been the last straw on the back of the industry.

After months of negotiation, however, a workable agreement was effected by the operators and development is now going forward at a rational rate, current production being of the order of 70,000 bbl. daily, instead of ten times that amount, as it might readily have been. State legislation and federal aid have played a part in assisting the industry's efforts to cure its ills and, while the patient is still far from well, his temperature has been lowered and his pulse is stronger and less rapid.

Among recent technical achievements are the greater depths being attained by the drill and the increasing use of liquefied petroleum gases in many branches of industry.

Twice within the past six months wells have been carried to depths in excess of 10,000 ft. The first well to pass this depth was drilled by a California operator in Santa Barbara County, and only within the past few weeks an American company operating in Mexico has broken this record by drilling with rotary tools to a depth of 10,580 ft., slightly in excess of two miles. The fact that neither well happened to be productive at the depths reached is in itself of no significance, the achievement being in the satisfactory attainment of the depth sought, thus giving promise of future exploitation of petroleum reservoirs lying at depths as great as 15,000 ft. without any marked change in equipment, methods, or materials now in use.

Many new products have come from the refineries within the last few years, but none more interesting, perhaps, than the liquefied natural gas products, chiefly propane and butane, which are now being made in increasing quantities by fractionating natural or casinghead gasoline and conserving and marketing the overhead from the stabilizer instead of wasting it to the air or burning it as local fuel. Cylinders of these gases are being supplied to isolated houses and communities for use in gas-heating appliances and liquefied butane is being used in increasing quantities as a substitute for acetylene in cutting operations.

Before leaving the field of recent developments, mention should be made of the rapid spread of the great network of natural-gas transmission lines which have been constructed in the past five years. Thus a byproduct of the petroleum industry bids fair to supplant artificial gas almost entirely within the next five years, provided pipe-line construction continues at its present pace.

Los Angeles Becomes A Rubber Center

By W. R. HUCKS
Pacific Goodrich Co.
Los Angeles, Calif.

THE development of the rubber industry on the Pacific Coast began with the organization of the Samson Tire & Rubber Co. and the building of a small tire-manufacturing plant at Compton, about ten miles south of Los Angeles proper. This took place in 1917, and aside from this one organization there were only a few small mechanical goods plants making molded rubber products for the plumbers' trade and for the oil-well supply houses.

From a small beginning, the Samson company went through a period of healthy growth, acquiring the former Savage plant located at San Diego. The disadvantages of operating two plants so widely separated and the additional business demand led to the building of a modern $8,000,000 plant at Los Angeles. This plant was built in 1929 and shortly thereafter the United States Tire & Rubber Co. entered this locality by affiliation with the Samson company and became the last of the large tire producers to locate on the Pacific Coast.

In 1919 the Goodyear Tire & Rubber Co. established a factory on the site of the old Ascot Speedway for the manufacture of tires and tubes for distribution in the western territory. At the same time this company established a textile mill for the manufacture of cotton fabrics and cord necessary for the production of tires.

Due to the post-war adjustments, little further expansion was made in the rubber industry until in 1927, when Goodrich and Firestone started their Pacific Coast plants. The former located a $5,000,000 plant on the east side of Los Angeles, the ultimate in straight-line production methods, and a high-efficiency rating in the production of tires and tubes has been maintained.

The Firestone company located on the south side of the city with an initial daily production of 5,000 tires and tubes. Its facilities were almost immediately increased to the present capacity of approximately 12,500 units. Firestone also built a modern reclaiming plant, the capacity of which has been increased commensurate with the expansion program.

The importance of the local manufacture of tires and tubes is indicated by the fact that for the calendar year of 1930, production carried on by the four major establishments, employing approximately 5,100 people with an annual payroll of $8,500,000, amounted to a total value of $53,500,000. These figures do not include the minor group doing a sizable volume in molded goods and repair stocks.

The Los Angeles district in volume and value of its rubber manufacturing easily ranks second in importance as a world rubber center. This district, as compared with any other rubber-producing section of the United States, offers peculiar advantages for the economical concentration of raw materials and distribution of finished products. Its location on tidewater enables crude rubber received from the Far East—that is, Singapore and the Straits Settlements—to be laid down at the mill door at a considerable saving per net ton as compared with Akron, Birmingham, and other rubber districts.

In addition to this particular saving, the scale of labor offers an outstanding inducement over other sections of the United States and, together with satisfactory and available raw materials, permits of manufacturing costs considerably under the standard costs of eastern plants. It has been pointed out that tires can be produced in this district and transported to Atlantic seaboard at the same cost if not at a saving over products made at Akron and placed in the same Atlantic seaboard warehouses. Oceanic rates from Los Angeles to the Orient and Australia are considerably less than from Baltimore or New York, and rates to Europe by the Panama Canal are on a par or substantially better than from Akron.

The market in southern California, Arizona, and New Mexico is about one-half of the total for the eleven western states with the predominant consuming center in Los Angeles. In addition to the original equipment business, there is a large replacement market, as California ranks high in the number of registered automobiles per capita.

The estimated daily production capacity of the combined four major companies is approximately 45,000 tires and 50,000 tubes, which will give employment to approximately 10,000 people and disburse an annual payroll of approximately $18,000,000. Aside from this production there is a reclaiming capacity of approximately 2,500,000 lb. per month divided among Xylos Rubber Co., a subsidiary of Firestone and located at Los Angeles; the Pacific R. & H. Chemical Co., located at El Monte; and the Pioneer Rubber Mills, located at Pittsburg, Calif.

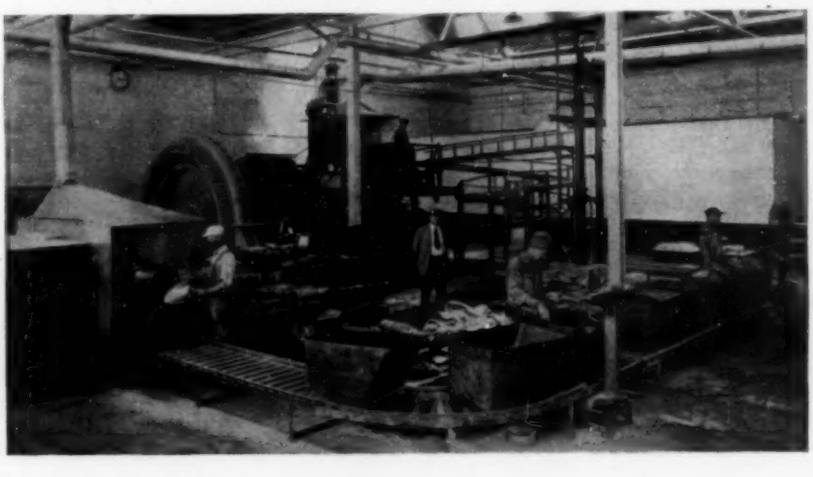
A further evidence of progress in rubber manufacturing in the Los Angeles district is evidenced to a considerable extent by the increased imports of crude rubber and outgoing shipments through the harbor of finished rubber products.

Shipments of tires and tubes for 1930 were as follows: foreign export, 4,500 tons, valued at $3,422,000—to Hawaii, 1,417 tons valued at $870,000; to intercoastal points, 1,737 tons valued at $1,528,000; to coastwise points, 10,791 tons, valued at $9,643,000.

In addition to the concentrated activity of the rubber industry in the Los Angeles district, there are rubber plants for tires, mechanical goods, and molded goods located in the North Pacific states. The outstanding plants are the Cord Tire Corp., at Portland, Ore.; the Coast Tire & Rubber Co., at Oakland, Calif.; and the Pioneer Rubber Mills, manufacturing mechanical goods, located at Pittsburg, Calif.

The factory manufacturing rubber from the guayule shrub is located at Salinas, Calif. This was described in the March issue of *Chem. & Met.* and constitutes an important raw-material reserve.

Weighing and Mixing Raw Materials in Plant of Pacific Goodrich Co.



Mining Water-Soluble Potash 1,000 Ft. Beneath the Surface at Carlsbad, N. M.

This photograph, taken by C. A. Pierce, general superintendent of the United States Potash Co., shows the underground workings of the first potash mine in this country.

Mining Potash in America

Large-Scale Production in New Mexico Forecasts Development of One of This Country's Largest Chemical Industries

CHEMICAL engineers who have failed to keep in touch with recent developments in the American potash industry may be surprised to learn that within the past year sylvite containing approximately 30 per cent K_2O is actually being mined and shipped in trainload quantities from the deposits of the United States Potash Co. at Carlsbad, N. M. When it is recalled that during the five-year period 1914-18 a great deal of patriotic effort and publicity, as well as perhaps $50,000,000, were expended in an almost futile effort to develop various domestic sources of potash, it is significant that the present project should have quietly proceeded to the stage of a successful commercial enterprise during the last few months. It is even more significant from the standpoint of the United States that we should develop a second important domestic source of supply for a material so essential to agriculture and industry.

The history of the Carlsbad development dates back to August, 1925, when potash was first identified in cuttings from an oil and gas test well sunk by the Snowden and McSweeney interests on a federal oil and gas permit held by them in Eddy County, New Mexico. Small quantities of both sylvite and polyhalite were found in the cuttings taken from depths below 1,300 ft. Encouraged by these indications, Snowden and McSweeney appropriated approximately $1,000,000 for further exploration and exploitation, and in April, 1929, a series of core tests were begun on government and state lands in this corner of New Mexico and the neighboring corner of Texas. In all, 46 diamond-drill test holes have been made, 20 under appropriation by the U. S. Government and 26 by private interests. All of these revealed polyhalite and about one-half showed sylvite in varying quantities.

Fig. 1—Selected Samples of Water-Soluble Potash From New Mexican Mines

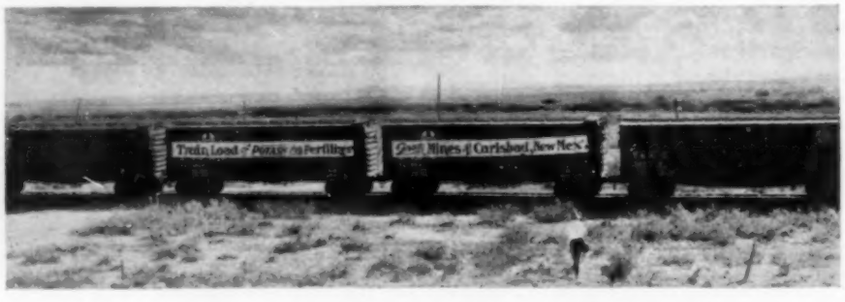
At left, sample of sylvite which when pure has a K_2O equivalent of 63.2 per cent. At right, a specimen of polyhalite less readily soluble and more difficultly refined than sylvite and containing, when pure, 15.6 per cent K_2O. Potash mined in Europe is rarely richer than 30 per cent K_2O

To proceed with the work of exploration and exploitation, the Snowden-McSweeney interests first formed the American Potash Co. and in 1930 incorporated this as the United States Potash Co. Leases for 7,680 acres were granted by the Secretary of the Interior and, in view of the pioneer work, the government agreed to the minimum royalty of 2 per cent. Excavation work on a four-compartment shaft was started in December, 1929, and within a year was carried to a depth of 1,062 ft. at an estimated cost of $250,000. A commercial bed of sylvite was struck at 980 ft., drifts were entered, and actual production started early in 1931. The first carload was shipped Jan. 10, 1931, to Wilmington, Calif., for experimental use. The first commercial shipment in March, 1931, was to the Dothan Guano Co., of Dothan, Ala. As mined it averaged 26.80 per cent K_2O.

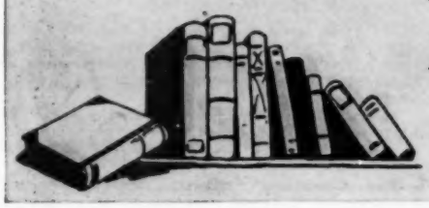
At the present time the ore is mined from the 1,000-ft. level, hoisted to the surface, ground, screened through 8-in. Cole screens, and then loaded on cars of the Atcheson, Topeka & Santa Fe R.R., which has built and operates a five-mile spur line between the potash mine and the main line of the Santa Fe near Loving, N. M. Present production is at the rate of several carloads a day, but the capacity of the shaft has been shown to be in excess of 500 tons per day.

Ever since the War, the Pacific Coast Borax Co. has held property on Searles Lake, Calif., with the view of either developing potash and borax production there or of becoming associated with any promising development that might result in the discovery of workable beds of potash ore. Such an opportunity was offered by the United States Potash Co. just about the time the shaft was being started at Carlsbad and a substantial interest was purchased from the Snowden and McSweeney interests. The borax company, because of its successful experience in the mining of rasorite ore in California, was able greatly to assist the mining operations at Carlsbad. Furthermore, the experience in Wilmington in the chemical refining of similar ore is also available to the new company and will be utilized in the new potash refinery which is now under construction near Loving, N. M.

In discussing the prospects of this new potash industry, one executive recently said that in his opinion, "it is one of the greatest developments that have occurred in the chemical world for many years." And he further characterized it as "an enterprise which will, I believe, become one of the biggest chemical industries in the United States."



Chemical Engineer's Bookshelf



Engineering Monograph

PLASTICITY. By *A. Nádai*, translated by *A. M. Wahl*. Engineering Societies Monograph, McGraw-Hill Book Co., New York City, 1931. 349 pages. Price, $5 ($4, for members).

Reviewed by F. H. NORTON

ARRANGEMENTS have been made by four national engineering societies (the civil, mechanical, mining, and electrical bodies) to assure the publication of worthy engineering books, otherwise unlikely to be printed, under the series title of "Engineering Societies Monographs." To this end the cooperation of the McGraw-Hill Book Co. has been obtained, and the individual volumes probably will be chosen under the sponsorship of the interested societies. In general their subjects will be selected for their immediate interest to the engineer in industry.

"Plasticity," the first of the Engineering Society monographs, is an excellent example of the service which this promises to bring to the engineer. In this case a work of fundamental importance to modern engineering is made available. In the past, stresses and strains have been computed on the basis of elastic conditions, but, due to the extensive use of metals at elevated temperatures in modern construction, the classic theories do not apply. At present, we often need to know the stresses under conditions of plastic flow. Information on this subject, which has been rather inaccessible to the engineer in the past, is brought together in this volume. Not only are the fundamentals of flow in the crystal lattice considered but practical applications of the theory are applied to actual cases; such, for example, as the stresses in thick-walled tubes. Dr. Nádai has treated this important subject in a thorough and readable manner.

General Electrochemistry

ELECTROCHEMISTRY. By *C. J. Brockman*. D. Van Nostrand Co., Inc., New York City, 1931. 348 pages. Price, $4.

Reviewed by M. DE KAY THOMPSON

ABOUT ten per cent of this work is taken up with the theory of electrochemistry, the rest of the volume with the applied electrochemistry of aqueous solutions, of gases, of fused salts, and of electrothermal processes. This book is so full of errors that it is of very questionable value to either students or general readers. The following quotations are given in proof of this statement:

Page 19: "23,040 cal. = 1 volt." "1 coulomb is 96,500 ampere seconds."

Page 20: The curve shown in Fig. 1 could not have been obtained with copper electrodes in copper sulphate, for this combination does not have a decomposition point. The explanation in the text would apply if the electrodes were unattackable. There is inconsistency in the convention as to the sign of single electrode potentials:

Page 25: The potential of metals that are on the same side of hydrogen as zinc are given the negative sign, while on page 87 magnesium and aluminum are called electropositive.

In Table VIII, page 96, copper is negative and iron is positive.

Page 91: Referring to "Case 2" as the common ion effect: "An example of Case 2 is the addition of H_2SO_4 to a solution of $CuSO_4.5H_2O$ to decrease the concentration of $Cu++$ by decreasing the solubility of $CuSO_4.5H_2O$ in the solution."

Page 113: The difference between the series and the multiple systems of copper refining is not correctly explained, and the illustrations do not agree with the text.

Page 190: "In copper plating, the migration of $Cu++$ towards the cathode must be sufficient to cause Faraday's Law to be obeyed, with respect to copper deposition, or else there will not be sufficient copper ions present at the electrode surface."

Page 196: "At the cathode the discharge $Na+$ will lead to the evolution of H_2 just as will the discharge of $H+$. But in the industrial electrolysis of neutral alkali chlorides the discharge of $Na+$ is very much desired, because with discharge the reaction is

$$Na+ + [-] + H_2O = NaOH + H_2$$

and the NaOH here is of great industrial importance."

Page 248: The Edison cell "consists of a positive electrode of finely divided iron . . ." and in the next line ". . . the negative electrode undergoes a transformation to $Fe(OH)_2$."

Page 249: "The great capacity of the negative plate prevents any noticeable losses owing to self-discharge."

Page 247: Speaking of the lead storage cell; "The discharging voltage is higher than the voltage of discharge as shown in the accompanying curve." Incidentally, there is no accompanying curve.

These are not all the errors the reviewer has found, but they are sufficient to prove the point.

Recent Arrivals

BRENNSTOFFTECHNISCHES PRAKTIKUM. By *M. Dolch*. Verlag Wilhelm Knapp, Halle (Saale), 1931. 148 pages. Price, 9.80 M.

THIS is a collection of methods for the laboratory examination of technical fuels taken largely from European, and particularly recent German, practice. In America, it will be of interest to the research worker in fuel technology and will find a place in the well-equipped technical library chiefly as a convenient compilation for reference. As the details of most of the methods differ from those prescribed for American industrial practice, it probably will find only occasional supplementary use in the routine laboratory here. Coal, gas, and tar and byproduct oil methods are incorporated, and 97 citations to the original literature are given.

AN INTRODUCTION TO ORGANIC CHEMISTRY. Second Edition. By *Roger J. Williams*. D. Van Nostrand & Co., Inc., New York City, 1931. 585 pages. Price, $3.50—Another successful organic chemical text has been brought up to date in this revision.

SELECTIONS FROM RECENT LITERATURE

CENTRIFUGAL FILTERS. Berthold Block. *Chemische Apparatur*, Oct. 10; pp. 210-3. The two principal purposes in using a perforated drum type of centrifugal filter are to provide maximum centrifugal effect, for thorough separation, and to permit easiest possible escape of the liquid from the centrifuge drum. But the two are incompatible, in that perforations favoring rapid escape of liquid are unfavorable to centrifugal effect. Hence the number, shape, size, spacing, and arrangement of perforations in the drum are factors requiring thought and ingenuity in order that the best possible compromise, with respect to operating costs and results, may be attained. Round holes are preferred, since square holes are punched instead of drilled, and punching introduces the cracking hazard. Round holes, drilled at an angle toward the direction of rotation, retard liquid escape; if drilled at an angle away from the direction of rotation, liquid escape is favored, but not sufficiently to compensate for the added cost. Hence radial drilling is preferred. For some purposes—e. g., when the solid material is fibrous—a copper drum is preferred, the perforations being slots with rounded ends. These slots should be cut with their axes in the radial, not the axial, direction of the drum, because axial slots weaken the drum a great deal more without giving any improvement in the ratio of drum surface to area of perforations. Flared perforations, having small holes on the inner face of the drum but much wider on the outer face, have some advantages, but not enough to compensate for the added cost and the weakening effect on the drum. Factors to be considered in the choice of spacing between holes are discussed, and various expedients are described and illustrated.

SPHEROIDAL TANKS. Stieglitz. *Chemische Apparatur*, Sept. 25; pp. 201-4. The success of the spheriodal tank (Horton type) as a container for liquids under high internal pressures has brought up the question of the adaptability of this construction to the storage of liquids with little or no excess of pressure. With this problem in view, the mathematics of the spheroidal tank design and the practical effects of pressure relations are discussed. Drawings and photographs are shown. The effort to increase the height of such tanks in proportion to their diameter led to a flask-shaped design, which is unsuitable in practice. From practical considerations, including a cost analysis, it is concluded that the spheroidal tank, when no large pressures are involved, is distinctly inferior to the cylindrical tank in the smaller capacities. It can compete with the cylindrical design only in the very large tank sizes. It is considered to be definitely established, however, that the spheroidal construction is superior for high pressures to an extent quite sufficient to compensate for the difficulties encountered in this design.

Recent Government Publications

Documents are available at prices indicated from Superintendent of Documents, Government Printing Office, Washington, D. C. Send cash or money order; stamps and personal checks not accepted. When no price is indicated, pamphlet is free and should be ordered from bureau responsible for its issue.

Permit Procedure Relating to Industrial Alcohol and Other Non-beverage Liquors. Bureau of Industrial Alcohol pamphlet. A factual outline.

Handbook of First-Aid Treatment for Injuries From Chemical Agents. Chemical Warfare Service pamphlet; 5 cents.

New Fertilizer Materials, by Albert R. Merz. U. S. Department of Agriculture Circular 185; 5 cents.

Census of Dyes and of Other Synthetic Organic Chemicals, 1930. U. S. Tariff Commission Report No. 19, Second Series; 20 cents.

Subject Index of U. S. Tariff Commission Publications. U. S. Tariff Commission document, revised September, 1931; 10 cents.

German Rust Preventives Market and I. G. Rustproofing Process, by George L. Brandt. Bureau of Foreign and Domestic Commerce Chemical Division Special Circular 346; mimeographed.

United States-Philippine Tariff and Trade Relations. U. S. Tariff Commission Report No. 18, Second Series; 25 cents.

Sulphur in Italy, by Elizabeth Humes. Bureau of Foreign and Domestic Commerce Chemical Division Special Circular 353; mimeographed.

Tariff Rates. U. S. Tariff Commission document in the Miscellaneous Series. Computed duties and equivalent ad valorem rates on imports into the United States from principal countries, calendar year 1929; 5 cents.

Cuban Market for Naval Stores, by Howard H. Tewksbury. Bureau of Foreign and Domestic Commerce Chemical Division Special Circular 354; mimeographed.

Production and Consumption of Naval Stores in Austria, by Gardner Richardson. Bureau of Foreign and Domestic Commerce Chemical Division Special Circular 348; mimeographed.

Mineral Production Statistics for 1930—Separate pamphlets from the Bureau of Mines on: Salt, Bromine, and Calcium Chloride, by A. T. Coons, 5 cents; Fullers Earth, by Jefferson Middleton, 5 cents; Gypsum, by R. M. Santmyers and Jefferson Middleson, 5 cents; and Graphite, by Jefferson Middleton, 5 cents.

Mineral Production Statistics for 1930—Preliminary mimeographed statements from Bureau of Mines on: Petroleum, petroleum products, and natural gasoline (final summary); "other finished products" of petroleum refineries; and natural gas.

Power-Using Industries of Italy, by A. A. Osborne. Bureau of Foreign and Domestic Commerce Trade Information Bulletin 772; 10 cents.

United States Trade With Latin America in 1930, compiled by H. S. Guista. Bureau of Foreign and Domestic Commerce Trade Promotion Series No. 124; 20 cents.

The Chemical Industry and Trade of Sweden, by William T. Daugherty. Bureau of Foreign and Domestic Commerce Trade Information Bulletin 774; 10 cents.

Economic Mineral Surveys. Mimeographed Information Circulars of the Bureau of Mines as follows: I.C. 6499, Boron and Its Compounds, by R. M. Santmyers; I.C. 6523, Pyrites (general information), by R. H. Ridgway; I.C. 6504, Umber, Sienna, and Other Brown Earth Pigments, by R. M. Santmyers; and I.C. 6518, Garnets (Gem Stones), by I. Aitkens.

Production of Syngenite and Byproduct Magnesia, by H. H. Storch and N. Fragen. Bureau of Mines Report of Investigations 3116; mimeographed. Part V of a study of the properties of Texas-New Mexico Polyhalite pertaining to the extraction of potash.

Added Recovery by Hydraulic Sizing of Fine Material in the Land-Pebble Phosphate District of Florida, by R. G. O'Meara. Bureau of Mines Report of Investigations 3139; mimeographed.

Utilization of Dolomite and High-Magnesium Limestone, by Paul Hatmaker. Bureau of Mines Information Circular 6524; mimeographed.

Studies on Determination of Sulphur in Gasoline, by Ralph H. Espach and O. C. Blade. Bureau of Mines Technical Paper 513; 5 cents.

Preliminary Report on Pyrolysis of Methane, by H. M. Smith, Peter Grandone, and H. T. Hall. Bureau of Mines Report of Investigations 3143; mimeographed. Part I of a study on the production of motor fuels from natural gas.

Hydrogen-Sulphide Content of the Gas in Some Producing Oil Fields, by John M. Devine and C. J. Wilhelm. Bureau of Mines Report of Investigations 3128; mimeographed.

Properties of California Crude Oils. IV—Additional Analysis, compiled by A. J. Kraemer. Bureau of Mines Report of Investigations 3074; mimeographed.

Methods of Extracting Volatile Oils from Plant Material and the Production of Such Oils in the United States, by Arthur F. Sievers. U. S. Department of Agriculture Technical Bulletin 16; 10 cents.

Documents on Insecticides for Control of Orchard Insect Pests. Three documents from the U. S. Department of Agriculture as follows: Farmers' Bulletin 1666, Insecticides, Equipment, and Methods for Controlling Orchard Insect Pests, by A. L. Quaintance, 25 cents; Circular 175, Experiments for the Control of the San Jose Scale With Lubricating-Oil Emulsions in the Pacific Northwest, by E. J. Newcomer and M. A. Yothers, 5 cents; and Technical Bulletin 253, Petroleum Oils and Oil Emulsions as Insecticides, and Their Use Against the San Jose Scale on Peach Trees in the South, by H. S. Swingle, 10 cents.

List of Technical Workers in the Department of Agriculture and Outline of Department Functions. 1931. U. S. Department of Agriculture Miscellaneous Publication 123; 25 cents.

Clay Products and Nonclay Refractories. 1930. Mimeographed production statistics from the Census of Manufactures.

Mineral Production Statistics for 1929—Separate pamphlets from the Bureau of Mines on: Gold and Silver, by J. P. Dunlop, 10 cents; and Coke and Byproducts, by F. G. Tryon and H. L. Bennit, 20 cents.

Pulpwood Consumption and Wood-Pulp Production; Production of Paper and Paper Boards; and Paper-Making Equipment in Use. Mimeographed statement from Census of Forest Products: 1930.

Government Publications Relating to Textiles, by Alvin E. Johnson. Third Edition. Bureau of Foreign and Domestic Commerce pamphlet.

Instructions for Handling Titanium Tetrachloride, Smoke-Screen Material. War Department Technical Regulations TR-1170-88; 5 cents.

EQUIPMENT NEWS
FROM MAKER AND USER

High Capacity Spray Desiccator

COMPLETE DRYING without injury to delicate organic materials, with high capacity per unit volume and high thermal efficiency, are important features of the Peebles spray drying system, which is being sold, designed, and erected throughout the world by the Western Precipitation Co., 1016 West 9th St., Los Angeles, Calif. This machine is a development of David D. Peebles, of Eureka, Calif., and in the several installations which have now been made in Pacific Coast plants has been found to bear out the claims to efficiency made for the new drying principle involved.

Although the desiccator does not differ widely from previous practice in the method of dispersing the solution or suspension to be dried, the means used to mix the dispersion with the drying air is novel, as well as the practice of shooting the dispersion at high velocity through a hot zone in which the greater part of the moisture is removed, then completing the drying in a cool zone before the solids are discharged from the apparatus. By this means, the bulk of the moisture is flashed off in such a short time that the solids are uninjured by the high temperatures employed. Use of high temperature makes possible a small, high-capacity apparatus, a small volume of hot gases, and consequently, a final collecting apparatus of minimum size.

The desiccator consists of a vertical cylindrical chamber, the bottom of which is slightly conical upward. The top, also slightly conical upward, contains at its center a well or tube extending downward, through which the high-speed centrifugal spray runner is introduced. Surrounding this tube is a conical casing terminating at the bottom in an annular opening a few inches above the runner. The opening contains radial vanes tilted at 45 deg. to give a vortex motion to the issuing hot gases. These enter at 800 deg. F. or more, direct from a heat exchanger or from the combustion gas passages of a furnace, depending on whether or not the product requires a clean gas. Surrounding this cone is an air jacket, also conical, which terminates at its lower end in a narrow annulus immediately surrounding the gas entrance. Cold air entering through the jacket prevents burning of the dried material should it come in contact with the cone forming the gas inlet.

At the opposite sides of the drying chamber, near the bottom, large tangential connections are taken off, one leading to the exhaust fan and thence to the collection equipment (filters or Multiclones), and the other to the recirculating fan. Discharge from the latter is returned tangentially to the drying chamber, but in the direction *opposite* to the rotation of the inner gas vortex. Hence, a cooler vortex rotates opposite to and outside of the hot inner vortex, so that drying of particles quickly shot through the hot zone can be completed slowly in a much cooler zone. A rotating arm carrying chains prevents settling of powder on the sides or floor of the chamber, so that all of the product is quickly removed with the discharge gas and caught, ready for sacking, in the collection equipment.

The dispersion mechanism, as previously mentioned, consists of a high-speed centrifugal runner. This is of special design, so built that the material is thoroughly broken up before issuing from the runner, to mix with the hot-air stream. Its shaft operates on ball bearings and it is automatically cooled and lubricated. Speeds range from 6,000 to 13,000 r.p.m., using a turbine, or motor and belt drive.

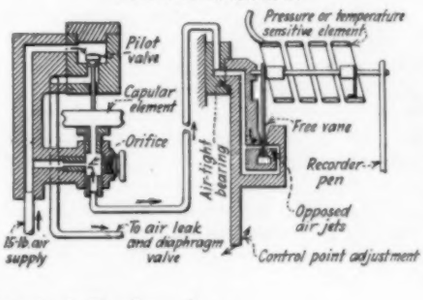
As it is manifestly impossible to describe this interesting new device adequately in the confines of this section, an illustrated article in a later issue will treat it completely, with both descriptive information and operating data.

❖

Air Operated Controller

FOR THE CONTROL of pressure and temperature, the Bristol Co., Waterbury, Conn., is offering a new line of air-operated recording controllers utilizing what is known as the "Free Vane" method of pilot control. The vane, which swings about a fixed point, is positioned by the sensitive element of the controller. In traveling between two opposed air jets, its position determines the quantity of air escaping from the jets, which in turn controls the expansion of a capsular element and hence the opening of a pilot air valve. The latter adjusts the pressure of the controlling diaphragm valve. These features will be apparent from the accompanying illustration.

Free-Vane Pilot System Used in New Recorder-Controller



A major advantage of the new system is the frictionless connection between the sensitive and controlling elements. The device is simple and is said to give results of extreme accuracy. Instruments are inclosed in a two-part cast-aluminum case containing either a spring-wound or a synchronous-electric clock. Cases are supplied for both flush and wall mounting. Using 12 in. charts, instruments are provided in both single and two-pen designs, the second pen of which may be temperature or pressure, depending upon whether the controlled function is pressure or temperature. Pressure ranges to 1,500 lb. and temperature ranges to 1,000 deg. F. are available.

❖

Pulley Covering

BELT SLIPPAGE is said to be completely eliminated by a new method of pulley covering known as "Gripwell." The materials for carrying out this method are supplied by the Gripwell Mfg. Co., 110 West 34th St., New York City. Application of Gripwell may be made by the user, or the manufacturer is prepared to do so in certain sections of the country.

The Gripwell system consists in covering the pulley with a specially processed and woven canvas, called "Gripwell Duktex," which is cemented to the surface of the pulley with Gripwell compound. The latter is a permanently adhering, acid- and solvent-proof cement which contains both neatsfoot and castor oils, so that the gripping surface also acts as a constant supply source of belt lubricant. Once the pulley has been covered, it is recommended that a thin coating of the compound be applied lightly twice a month during the life of the covering. This method requires no belt dressings, permits the use of a slack belt, is guaranteed to reduce slippage materially, and is said to increase belt life in all instances. Gripwell cement may also be used for other industrial cementing problems.

❖

Standard Steam Generator

STANDARDIZATION of its line of Combustion Steam Generators has been announced by the Combustion Engineering Corp., 200 Madison Ave., New York City. The line includes eight sizes with capacities ranging from 70,000 to 400,000 lb. of steam per hour, from and at 212 deg. F. The design combines in one unit all elements required for fuel burning, steam gen-

eration, superheating, heat recovery, and ash disposal. All four walls of the furnace are water-cooled and there are no exposed refractory surfaces. The furnace is fired with powdered coal by the corner tangential system. Other features include a superheater bypass damper for controlling superheat temperature, compactness and simplicity of design, and a casing which is air- and dust-tight throughout.

❖

Safety Switch

A COMBINATION safety switch and magnetic contactor for small a.c. motors up to 5 hp. has been introduced by the Rowan Controller Co., Baltimore, Md. The unit is compactly built and is completely oil immersed, making it vapor-proof, weatherproof, and dust-proof Other equipment is available if overload protection is desired.

❖

Propeller Ventilating Fan

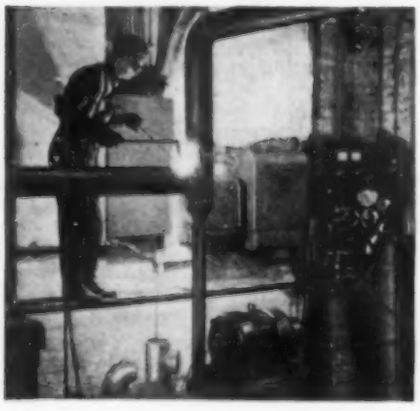
HIGH EFFICIENCY and quiet operation are said to be characteristics of a new six-bladed propeller fan recently introduced by the B. F. Sturtevant Co., Hyde Park, Boston, Mass. The fan is direct-connected to a motor and mounted in a streamline ring for which a mounting panel is available. Fans are made in diameters from 12 to 25 in. for moving from 1,000 to 4,400 cu.ft. of air per minute. Available accessories include automatic shutters, safety guards, and penthouses.

❖

Fittings for Welding

DEVELOPMENT of a complete line of seamless steel pipe fittings for welding has been announced by the Taylor Forge & Pipe Works, Chicago, Ill. The line includes elbows, tees, reducing tees, bull plugs, reducing nipples, and forged steel butt-welding flanges. Sizes to 12 in. are at present available and it is anticipated that the line will shortly be extended to 24 in. The fittings are light in weight, of full strength and are beveled ready for welding by machine. Their use is said to result in uniform strength, unimpaired flow and lower installation cost.

Line Being Built of Seamless Forged Fittings



Welded Speed Reducer

GREATER STRENGTH than is obtainable in cast-iron housings is said to be inherent in a new line of welded, rolled-steel housings now provided by the Philadelphia Gear Works, Erie Ave. and G St., Philadelphia, Pa., for its line of speed reducers. The company is now prepared to supply the new casings for any of the reducers of its manufacture. In addition to greater strength, the new housings are said to provide greater protection from contamination of the lubricant.

❖

Unit Air Washer

UNIT CONSTRUCTION has been applied to the design of a new air washer put on the market by the Buffalo Forge Co., Buffalo, N. Y. The device consists of a washing section, including spray nozzles, eliminator plates, and a pump for recirculating the water. Heating coils may be provided for use in cold weather. Air is moved through the washer by means of two or more multi-blade fans. Based on capacity without the heater, these units are obtainable in sizes passing from 1,195 to 7,260 cu.ft. of free air per minute.

❖

Compact Hydraulic Transmission

ANNOUNCEMENT is made by the American Engineering Co., Philadelphia, Pa., of a compact 5-hp. electro-hydraulic transmission capable of delivering a constant torque at any speed from zero to the motor speed of 1,150 r.p.m., and in either direction. The transmission consists of an electric motor which drives a multi-cylindered pump of the Hele-Shaw type, which pump in turn drives a hydraulic motor of similar design. The principal difference between the motor and the pump lies in the fact that the former has a fixed stroke, while the stroke of the pump may be varied by means of a handwheel. The pump end of the electric motor shaft is provided with a fan which cools the circulating oil in the hydraulic system as it passes through finned tubing surrounding the fan.

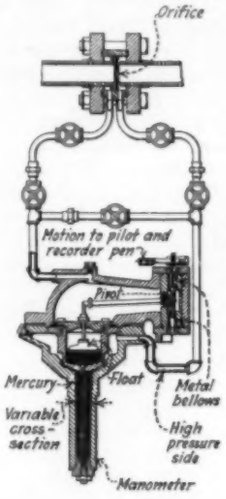
❖

Manganese Electrode

BUILDING UP worn manganese-steel castings by means of the shielded arc process is the function of the new "Manganweld" electrode announced by the Lincoln Electric Co., Cleveland, Ohio. This electrode is made of 11 to 15 per cent manganese steel and is air toughening. The coating on the rod is said to provide a shielded arc which insures a minimum of arc disturbance and provides non-oxidizing conditions. The weld is said to remain Austenitic even under slow cooling. The deposited metal, after cold working, is reported to attain a Rockwell C hardness of 45 to 50.

New Flow Instruments

RECENT announcements of the C. J. Tagliabue Mfg. Co., Park and Nostrand Aves., Brooklyn, N. Y., describe a new line of flowmeters and flow controllers which this company has placed on the market. Instruments are available for recording and controlling (or recording alone) the flow of both liquids and gases. Through the use of a special type of mercury manometer which varies in cross-section according to the "square" law, these instruments are of the uniform-chart type, reading directly



Manometer and Orifice Used in New Flow Instruments

in units of flow or in per cent of the maximum flow measurable with the particular instrument.

The accompanying sketch illustrates the manometer and orifice used with the new meter and controller. It will be observed that the equal-chart-division feature is obtained by the variable cross-section of the outer manometer chamber. Another feature of importance is the elimination of the pressure-tight bearing for transmitting manometer position to the recording and controlling mechanism. This is accomplished by means of opposed metal bellows through which the float motion is communicated. This method is said to eliminate friction and the possibility of leakage.

Control is accomplished through the use of a pneumatic pilot (not shown) which regulates a balanced diaphragm valve. Position of the recorder pen controls air leakage from small orifice, which in turn adjusts the setting of the pilot air valve through expansion or contraction of a capsular (air relay) spring. A bypass between the air relay and the controlled air line balances the controller and is said to prevent any "hunting" action. This feature is said to maintain the diaphragm valve opening at the required demand point over the full range of valve opening.

❖

All-Steel Mill

WELDED, all-steel construction is used in the new line of Type AS pebble mills manufactured by the Patterson Foundry & Machine Co., East Liverpool, Ohio. They are built for either

belt or motor drive, the latter making use of an inclosed, silent-chain drive. The mills are of somewhat lighter construction than the Type D line made by this company and are not intended to replace the latter.

Type AS mills are offered in nine sizes, ranging from 2½x3½ ft. to 6x10 ft., with capacities ranging from 80 to 2,100 gal. (1,750 gal. if lined). Available linings include porcelain and buhrstone. Lined mills are charged with flint or porcelain pebbles or balls, and unlined mills with alloy metal balls.

❖

Small Speed Reducers

FOR SMALL motor drives in ratios from 12 to 72, the W. A. Jones Foundry & Machine Co., 4401 Roosevelt Road, Chicago, Ill., has announced two new double-reduction speed reducers, Types 90-D and 105-D. The initial reduction is made between double helical gears. The low-speed reduction consists of an accurately generated Maag pinion and gear. Timken bearings are used throughout.

❖

Ratio Combustion Meter

FOR USE as a combustion guide in the firing of gas- and oil-fired heaters, furnaces, and similar equipment, the Bailey Meter Co., 1050 Ivanhoe Road, Cleveland, Ohio, has introduced a ratio meter to assist operators in maintaining a definite relation between the quantities of air and fuel supplied to the furnace. The meter consists of a two-pen orifice meter, recording the flows of both air and fuel. At the time the meter is installed, complete combustion tests are made on the furnace to determine the most suitable air-fuel ratio for various combustion conditions. The air-flow mechanism is then adjusted so that this ratio always is obtained when the two records coincide. If in operation the two records do not coincide, the relative positions of the pens indicate to the operator whether the air supply is too great or too small. The meter integrates the flow of fuel, and may also be equipped with a temperature or pressure pen if desired.

Air-Fuel Ratio Meter

New Motor Starters

TWO NEW across-the-line motor-starting switches have recently been announced by Cutler-Hammer, Inc., 219 North 12th St., Milwaukee, Wis. One is a float-operated single-pole, double-break starter, providing thermal overload protection for ½-hp. a.c. motors and ⅓-hp. d.c. motors. It is intended for controlling small sump pumps and in similar applications. The second starter is an explosion-proof, oil-immersed switch with thermal overload protection for Underwriters Class 1 group D hazardous locations (solvents, lacquers, gasoline, alcohol, etc.). Due to its oil immersion, the starter also is corrosion resisting and, therefore, is suitable for location in corrosive rather than hazardous atmospheres.

❖

Improved Gaskets

IMPROVEMENT in its line of "Flexitallic" gaskets has been announced by the Flexitallic Gasket Co., Eighth and Bailey Sts., Camden, N. J. This gasket is made from a strip of whatever metal is necessary for the service, the center of which is formed into a V-shaped, spring-like crease. This strip is wound between two strips of asbestos into the form of an annulus of the proper number of plies. The resulting gasket has 19 plies per inch. The improvement consists in adding double thicknesses of metal at four places in the gasket, with two clinched and soldered outside "end-offs" where the winding is stopped and the metal strip is soldered to the next inside strip. This makes it possible, in re-using the gasket, to strip off of the outside plies in case they have been damaged, leaving a somewhat smaller but still perfect gasket.

❖

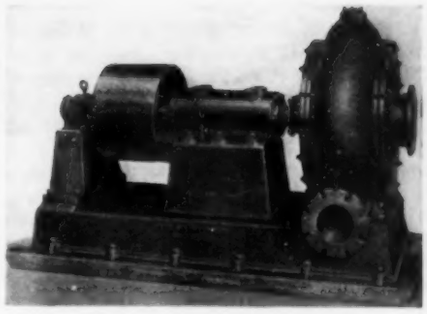
Monobloc Pumping Unit

CLOSE-COUPLED construction is embodied in the new Monobloc Type D centrifugal pump recently developed by the Worthington Pump & Machinery Corp., Harrison, N. J. The pump body is bolted to the extended motor frame and the impeller is mounted on the end of the continuous motor shaft. The design is simple, incorporating among other features a shaft sleeve which passes through the stuffing box and which is part of the impeller: a cadmium-plated steel locking device for the impeller; and a forged bronze packing gland. The range of sizes provides for capacities up to 140 g.p.m. and heads to 90 ft. Maximum capacity at maximum head of 115 ft. is 65 g.p.m.

❖

Abrasion-Resisting Pumps

MANY new features have been included in the new Type C Amsco manganese-steel pump recently offered by the American Manganese Steel Co., Chicago Heights, Ill. One important feature is the provision of an especially long main bearing. This handles both thrust and axial loads, thus simplifying lubrication. Both ring-oiled and anti-friction bearings of either the ball or roll type are available. The pump may be obtained for both belt and direct motor drive. Impeller clearances and main bearings, it is said, can be adjusted easily without dismantling the pump.



Type C Manganese Steel Pump

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Manual Fuel Valve

THROUGH modification of a valve originally developed for automatic control, the Automatic Temperature Control Co., 34 East Logan St., Philadelphia, Pa., is now prepared to offer a manually operated fuel valve capable of giving close regulation of oil fuels at flow rates from 1 qt. to 100 gal. per hour. The valve consists of a body and tapered plug, the latter containing three triangular orifices of varying sizes, so arranged that any one or any combination of the orifices may be used. When the valve is closed, a change of its capacity is readily made by removing or inserting in place screws which blank off the several orifices. A modification of this valve, intended for larger capacities up to 450 gal. per hour, makes use of a disk with triangular openings, rotating over a port plate. Both valves are available with ½-in. screwed connections, although larger valves can also be supplied.

❖

Sealing Compound

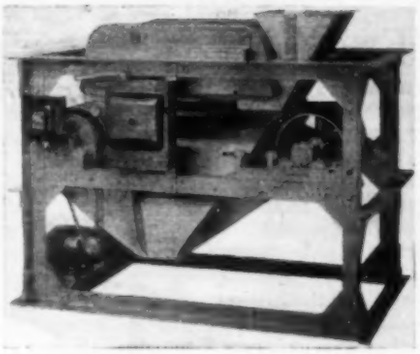
"HYDRO-SEAL" is the name of a new sealing compound for making tight joints in lines carrying water, gas and air, put out by the Quigley Co., 56 West 45th St., New York City. The material is supplied in cans, buckets, and drums; is ready for use without stirring or other treatment; and is used for sealing thread, flange, and gasket joints. It serves as a lubricant in making the joint and is said to remain plastic indefinitely, making frozen joints impossible.

❖

Magnetic Separator

STEARNS Type Q is the designation of a newly designed magnetic separator for extremely finely ground materials which has been announced by the

Magnetic Manufacturing Co., Milwaukee, Wis. It is claimed for the new machine that it will completely separate free iron from solids ground to 20 mesh or finer, and that the result is attained by the use of an ingenious and original type of construction not found in any earlier separator. The machine, as appears from the illustration, is of unit construction, embodying its own driving motor and speed reducer. It is recommended by the manufacturer for use in the production of ceramic materials and pottery, plastics and resinous products, as well as other finely pulverized process materials.



Magnetic Separator for Fine Solids

Manufacturers' Latest Publications

Air Conditioning. Niagara Blower Co., 6 East 45th St., New York City—Abstract No. 1—12 pages briefly describing the purpose and application of air conditioning and giving a psychrometric chart with instructions for its use.

Air Separation. Raymond Bros. Impact Pulverizer Co., 1302 North Branch St., Chicago, Ill.—Folder describing the "whizzer" type mechanical air separator made by this company.

Burners. Denver Fire Clay Co., Box 1107, Denver, Colo.—Bulletin 306—7 pages on this company's Type C atmospheric gas-boiler burner.

Chemicals. Grasselli Chemical Co., Cleveland, Ohio—8-page folder on the properties and uses of sodium meta-silicate.

Chemicals. The Neville Co., Pittsburgh, Pa.—Bulletin 7—Leaflet describing the properties of "2-50-W" white solvent naphtha for synthetic resins, supplied by this company.

Chemicals. Philadelphia Quartz Co., 121 South 3d St., Philadelphia, Pa.—Bulletin 465—13 pages on the use of sodium metasilicate in electroplating.

Coatings. Liquilox Co., Box 1026, Burbank, Calif.—Folder describing Liquilox, a heat-, acid-, and alkali-resisting coating for general industrial use.

Consultation. Foster D. Snell, Inc., 130 Clinton St., Brooklyn, N. Y.—15-page brochure describing the consulting services and listing the technical staff of this consulting firm.

Disintegration. Hardinge Co., York, Pa.—Folder Ah254—Briefly lists performance data on a Hardinge conical mill used in a cement plant for raw-material grinding.

Disintegration. Traylor Engineering & Mfg. Co., Allentown, Pa.—Bulletin 1,110—13 pages on the Type TZ gyratory crusher produced by this company.

Dryers. Louisville Drying Machinery Co., Louisville, Ky.—1932 general catalog, 31 pages, describing the rotary dryers, continuous filters, and continuous screens made by this company.

Electrical Equipment. General Electric Co., Schenectady, N. Y.—Publications as follows: GEA-940B, pipe fittings for panel- and benchboards; GEA-959C, oil circuit breakers, triple-pole, single-throw; GEA-1061D, recording instruments for alternating and direct current; GEA-1146A, 24 pages, highly illustrated, describing electric furnaces; GEA-1498, describing G.E. Selsyn differential follow-up systems.

Equipment. S. F. Bowser & Co., Fort Wayne, Ind.—14 pages completely describing this company's new "Uni-Pass" system for the reclamation of electrical oils. The method employs vacuum evaporation and pressure filtration through porous metallic filter media.

Equipment. General Ceramics Co., 71 West 35th St., New York City—8-page reprint of an article by Percy C. Kingsbury on "Applying Industrial Chemical Equipment to Corrosion Problems in the Textile Industry."

Equipment. Sharples Specialty Co., 23d and Westmoreland Sts., Philadelphia, Pa.—Folder briefly describing the new Sharples "Deoxator," a machine for the purification of insulating oils; it combines a supercentrifuge, heater and blotter press, and operates under vacuum.

Equipment. F. J. Stokes Machine Co., Olney P. O., Philadelphia, Pa.—Leaflet briefly describing miscellaneous types of plant and laboratory experimental equipment made by this company.

Fans. B. F. Sturtevant Co., Hyde Park, Boston, Mass.—Bulletin 381—19 pages on the "Design 4 Silent Vane" fan made by this company.

Furnaces. W. F. Rockwell Co., 50 Church St., New York City—Bulletins 318 and 320—Respectively describing the roller hearth furnace and various other furnaces made by this company for treating metallurgical, ceramic, and chemical products.

Gasoline Treatment. Universal Oil Products Co., 310 South Michigan Ave., Chicago, Ill.—Booklet 99—Describes the use of dyes in saving money on gasoline treatment.

Heat-Exchange. Thermal Engineering Co., 701 Spring Arcade Bldg., Los Angeles, Calif.—10-page folder describing the so-called "convertible" heat exchangers for liquids, fluids and vapors made by this company.

Instruments. The Bristol Co., Waterbury, Conn.—Catalogs 2025 and 2050—Respectively 19 and 26 pages on thermometer controllers and pyrometer controllers; each includes auxiliary equipment.

Instruments. Brown Instrument Co., Philadelphia, Pa.—Catalog 2002—55-page catalog illustrating and describing the electric flowmeters made by this company.

Instruments. Esterline-Angus Co., Indianapolis, Ind.—Bulletins 731 and 831—Respectively concerning the use of graphic instruments in the Masonite Corp.'s plant; and the use of time recorders for plant supervision.

Materials Handling. American Car & Foundry Co., 30 Church St., New York City—Bulletin 102—6 pages on the numerous types of equipment of industrial railways supplied by this company.

Materials Handling. Fairfield Engineering Co., Marion, Ohio—Bulletin 60-1—Illustrates graphically the effective use of skip hoists in actual and typical installations.

Power Transmission. E. F. Houghton & Co., Philadelphia, Pa.—148-page catalog on "Vim" short-center drives, including an enormous amount of application data and numerous useful engineering tables.

Power Transmission. Morse Chain Co., Ithaca, N. Y.—Bulletin 47—24 pages, handsomely illustrated, describing the flexible chain couplings made by this company.

Power Transmission. Westinghouse Electric & Mfg. Co., Nuttall Works, Pittsburgh, Pa.—4 pages describing the Westinghouse-Wise multi-speed drive.

Pressing. Fred S. Carver, 345 Hudson St., New York City—24-page booklet describing the hydraulic laboratory press made by this company.

Pumps. American Manganese Steel Co., 389 East 14th St., Chicago Heights, Ill.—Folder describing the Type C materials-handling pump made by this company.

Pumps. Ingersoll-Rand Co., 11 Broadway, New York City—11-page catalog on the close-coupled Cameron motor pump made by this company.

Pumps. Schutte & Koerting Co., Philadelphia, Pa.—Bulletin 17-A—24 pages on the numerous types of gear pumps made by this company.

Pumps. F. J. Stokes Machine Co., Olney P. O., Philadelphia, Pa.—Bulletin 149-A—8 pages on this company's high vacuum rotary pumps.

Pumps. Worthington Pump & Machinery Corp., Harrison, N. J.—Publications as follows: W-312-S2A, Type L centrifugal pumps; W-312-S3A, Type LA centrifugal pumps; W-312-S9, Type LL centrifugal pumps; W-318-S3A, Type UB centrifugal pumps; D-112-B3, steam pumps for oil manufacture; D-412-S-5, horizontal duplex power pumps; D-423-E10, vertical triplex power pumps; WD-310-B3, sump, irrigation and drainage pumps; DW-110-B1, simplex and duplex steam pumps; D-412-B1, horizontal and vertical power pumps.

Refractories. McLeod & Henry Co., Troy, N. Y.—Catalog No. 231—32-page bulletin describing this company's refractory shapes for furnace linings and arches.

Refractories. Chas. Taylor Sons Co., Cincinnati, Ohio—4-page booklet describing the use and properties of a Sillimanite air-setting cement for furnace construction and repairs.

Research. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.—Handsomely illustrated 48-page brochure entitled "Stories of Westinghouse Research."

Rust-Proofing. Parker Rustproof Co., 2177 East Milwaukee Ave., Detroit, Mich.—6-page booklet describing the new "Parcolite" spray-gun-applied method of rust-proofing recently developed by this company; a phosphate treatment.

Screens. Ludlow-Saylor Wire Co., St. Louis, Mo.—Redistribution of a booklet concerning this company's "Spring-Steel" woven-wire screens, previously described in Chem. & Met.

Screens. Simplicity Engineering Co., Durand, Mich.—4-page folder describing a new line of gyrating screens made by this company.

Speed Reducers. Universal Gear Sales Corp., 19th & Martindale Ave., Indianapolis, Ind.—Catalog 100—76-page book describing the principle and application of the "Heliocentric" speed reducer made by this company.

Steam Generation. Babcock & Wilcox Co., 85 Liberty St., New York City—Bulletin describing the new Type H Sterling boiler made by this company.

Steam Generation. Combustion Engineering Corp., 200 Madison Ave., New York City—Bulletin MC-1—Folder describing this company's multiple-circulation boiler.

Steel Treatment. Roessler & Hasslacher Chemical Co., Empire State Building, New York City—80-page booklet on the heat treatment of steels, using cyanides and salts.

Transportation. General American Tank Car Corp., 122 E. 42d St., New York City—Reprint of 7-page article by L. A. Belding, entitled "Liquefied Petroleum Gases in Transit."

Tubing. Parker Appliance Co., 10320 Berea Rd., Cleveland, Ohio.—Miscellaneous leaflets and bulletins describing a complete line of couplings for large and small tubing; copper tubes; pad couplings for tubes; and tools for tube flaring and bending.

Tubing. Scoville Mfg. Co., Waterbury, Conn.—20-page book describing and illustrating the properties of the alloy "Alcunic," a copper-nickel-aluminum-zinc alloy for condenser tubes.

Valves. Cleveland Brass Mfg. Co., 4606 Hamilton Ave., Cleveland, Ohio—Bulletin describing this company's "Acimet" valve for sulphuric-acid handling.

Valves. Merco Nordstrom Valve Co., 343 Sansome St., San Francisco, Calif.—172-page catalog illustrating approximately 30 types of lubricated plug cocks in various metals made by this company.

Water Cooling. Binks Mfg. Co., 3114 Carroll Ave., Chicago, Ill.—Bulletin 6-E—35-page book describing water-cooling equipment including spray ponds, cooling towers, and accessories.

Waterproofing.—Barnsdall Tripoll Co., 2111 Railway Exchange Bldg., St. Louis, Mo.—Bulletin E—4 pages on the use of Barnsdall Admix as an integral waterproofing for concrete, mortar, and cement products.

Water Treatment. The Neckar Co., 67 Wall St., New York City—32 page illustrated bulletin describing the Neckar process of boiler feed-water treatment, featuring recirculation and automatic blow-down.

Welding. Torchweld Equipment Co., 224 North Carpenter St., Chicago, Ill.—Bulletin 31—32 pages on welding equipment including welding and cutting torches, auxiliaries and supplies.

X-Ray Examination. Combustion Engineering Corp., 200 Madison Ave., New York City—5-page reprint of an article on the "X-Ray Examination of Welded Pressure Vessel Seams."

Zinc Plating. New Jersey Zinc Co., 160 Front St., New York City—Research bulletin of 17 pages on the plating of rolled zinc and zinc die castings.

NEWS *of the* INDUSTRY

Welding Tests Feature Association Meeting

AT THE annual meeting of the International Acetylene Association, held at the Congress Hotel, Chicago, Nov. 11-13, an entire session was devoted to a discussion of the problems of the chemical industry. The boiler code revision was cited as a factor which would open up a new field for welding. It was predicted that no difficulty would be found in meeting specifications. While X-ray examination was given full credit as a precautionary measure, the opinion was voiced that it would gradually become less important as confidence in the efficiency of welding increased. The rapid advance of machine gas cutting was stressed, with appreciable saving in time and material. It also made possible the development of new designs. This method of precision cutting, however, was pointed out as useful mainly in routine shop work.

The growth of nickel and alloy welding was emphasized in a review of the numerous applications which are now made. Monel metal, for instance, was found to be used in dryers, stills, condensers, centrifuges, spraying equipment, and in equipment for alkali production. Nickel liners, replaceable and adaptable to old equipment, were reported to be growing in favor. The use of thin sheets for lining storage tanks fabricated by lock-seaming and silver soldering also was discussed.

F. W. Martin, in his paper on high-pressure steam-line welding, emphasized the necessity of rigid adherence to specifications.

The public meeting on Nov. 11 was featured by testing demonstrations. At the final session the Morehead Medal was awarded to A. C. Morrison, secretary-treasurer of the association.

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A.I.Ch.E. Will Meet at Atlantic City

THE twenty-fourth annual meeting of the American Institute of Chemical Engineers will be held at Haddon Hall, Atlantic City, Dec. 9-11. The executive secretary, assisted by the Philadelphia Committee of 1929, is general chairman of arrangements and has drawn up a program with a view of utilizing as much time as possible for business and technical sessions. Contrary to custom, the program will not include visits to plants. Both the morning and afternoon sessions on Dec. 9 will be devoted to a symposium on "Stream Pollution and the Treatment of Industrial Wastes." Technical sessions also will be held on Dec. 10 and Dec. 11.

A.I.Ch.E. Postpones British Trip

Members of the American Institute of Chemical Engineers will shortly receive a copy of an official bulletin advising of a change in plans for the summer meeting which was to be held in England, June, 1932. This joint session with the British Institution of Chemical Engineers has been postponed to such a later date as will be mutually agreeable to both organizations. Plans are under way to hold the 1932 meeting at Schenectady and Corning, N. Y., the present intention being to spend the first two days at Schenectady and the final day at Corning.

New York Electrochemists Will Meet at Pratt

THE fall meeting of the Electrochemical Society, New York Section, will be held on Nov. 20, 1931, at 8 p.m. at Pratt Institute, Ryerson St. near Willoughby Ave., Brooklyn, N. Y. Non-members will be welcomed.

The program of papers is as follows: "The Debye-Hückel Theory: Its Present Status, Its Value and Its Limitations in Calculating the Activities of Electrolytes," by Dr. Victor K. La Mer; "Some Economic Aspects of the Electrochemical Industries," by Dr. Charles L. Mantell. Discussion of these papers is invited.

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European Nitrate Cartel Liquidated

WHILE various reports have been circulated to the effect that efforts would be made to revive attempts to form an agreement among European producers of nitrogen, it is now evident that no such plans are in anticipation. Reports from abroad state that the recent conference of European nitrogen producers was brought to an end after completing arrangements for the liquidation of the cartel.

Pacific Coast T.A.P.P.I. Members Meet

TECHNICAL men representing the majority of the pulp and paper mills in Oregon, Washington, and British Columbia were present at one of the most important gatherings of the year in the Pacific Coast pulp and paper industry, when fifty members of the Technical Association Pulp and Paper Industry assembled at Powell River, B. C., for their fall convention. A. H. Lundberg, of the G. D. Jenssen Co., spoke on "New Developments in Sulphite Cooking"; P. Sandwell, resident engineer of the Powell River Co., presented a paper: "Some Dryer Experiments," which provoked considerable discussion. Harry Andrews, Powell River plant chemist and vice-chairman of the T.A.P.P.I. association, officiated as chairman. Probably the most interesting feature of the convention, however, was the address of Dr. Jahn, of the University of Idaho, whose theme, "Uses of Cellulose Other Than in Paper Making," embodied years of studied research. Ralph Hansen, of the Weyerhaeuser Timber Co., was elected president of the Pacific coast section for the forthcoming year.

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Stauffer Chemical Forms Rubber Subsidiary

ANNOUNCEMENT is made of the formation of the Pacific Hard Rubber Co. at Los Angeles, Calif. A plant is now under construction for the manufacture of hard-rubber battery containers. The plant will be equipped with the most modern machinery. The new company will be closely associated with the United Rubber Corp., of San Francisco. Officers of the company are John Stauffer, Jr., president; Herbert King, vice-president; and W. C. King, secretary-treasurer.

Ownership and control of the company is vested in the Stauffer Chemical Co., the arrangement providing an additional outlet for chemicals used in production of reclaimed rubber and rubber boxes.

The Stauffer Chemical Co. also has a plant nearing completion for the manufacture of superphosphate. This plant will have a capacity of approximately 12,000 tons of superphosphate annually. Phosphate rock from Idaho and Wyoming will be used.

New Problems Confront Gas Industry

EDITORIAL STAFF REPORT

GAS MANUFACTURE was formerly the outstanding technical problem of the public-utility gas business. Now the problems of transmission for long distances and distribution within a community are becoming constantly more prominent. This was evident from all of the technical proceedings of the 1931 annual convention of American Gas Association, which was briefly reported in the news pages of *Chem. & Met.* last month.

Natural gas has a great deal to do with this changed situation. However, the byproducts of the petroleum industry and changed methods of using petroleum products for gas making also are significant factors. Indeed, the production engineer is today largely a selection engineer, confronted with questions which are essentially the choice between different sources of gas supply. This is particularly true in the northeastern quarter of the United States, the band from Missouri to Minnesota and eastward.

The cost of this natural product delivered to the city gates cannot be gaged by its low cost in the producing field. Five-cent gas often becomes 50-cent gas when the capital charges for pipe lines are added. And a natural gas available for nothing in the field would be too costly to consider at the destination if it were to be used for supplying only peak loads in which house heating is involved.

Even the most ardent advocates of natural-gas development now stress questions of load factor on pipe lines. Formerly there was a tendency, under the enthusiastic pressure of investment banking concerns, to ignore this question of capital costs when marketing pipe-line securities. Such a condition, of course, is not safe either for the investor or the public-utility company; nor is it desirable from the user-public point of view. It is refreshing, therefore, to find such an outstanding utility executive as Judge H. O. Caster, general counsel of Henry L. Doherty & Co., raising the question of the propriety of indefinite natural-gas extension, in the following language:

"The investment in these super-lines is enormous, and it behooves those who are contemplating the undertaking of their construction to make the most careful study both of the field, to determine the adequacy of the supply and of the market, to be assured that reasonable rates can be secured over a sufficient length of time to amortize the investment."

Within the limits of cities served by distributing companies analogous problems arise. This fact was never more clearly stressed than in the discussion of economics of gas distribution, by W. C. Beckjord, who made rather an unusual analysis of the trends in capital investment for distribution systems. Pointing out a logical method for analyzing such cases, he presented a convincing demonstration of the theory that today the outstanding job of a gas engineer is to lower capital investment required per unit of gas distributed. Only by turning the trend of investment in that direction does it appear practicable for gas to continue to serve constantly increasing percentages of the community requirement.

Both within the city, as pointed out by Beckjord, and in long-distance transmission lines, as discussed by R. W. Hendee, is there a pronounced tendency toward higher operating pressures. For transmission lines, operation at as high as 900 lb. per sq.in. is already contemplated on at least one line. This means that the pipe must be made of a yield strength of at least 75,000 to 80,000 lb. per sq.in.; and the task of jointing becomes correspondingly important. These high pressures, of course, are one reason for the tendency widely noted during the last few years of using welded lines.

Problems of selecting a source of gas and blending mixtures from various sources have been presented recently in *Chem. & Met.* (John H. Wolfe, pp. 578-581, October, 1931.) Problems there outlined received careful attention in a number of convention papers, with particular emphasis by J. A. Perry on the fact that sharp distinction must be made in the economic problem when selecting a base-load gas and when arranging for peak-load production. For this latter purpose, not only high-pressure storage to meet peak-hour demands but higher pressures of transmission for peak days and peak seasons are now being suggested.

The utilization of petroleum-refinery byproduct gas has introduced a number of problems, among which not the least important is that of removal of large quantities of sulphur at a low unit cost. Petroleum refiners, as well as gas-company executives who meet this problem, will find a wealth of suggested material in a report rendered by the sub-committee on purification of high-sulphur gases.

For peak-load supply the use of modified water-gas equipment is now widely recognized as the most economical because of the tremendous capacity that may be attained with a minimum of investment cost. For such service it is, of course, entirely proper to subordinate the question of operating cost to that of capital charges, since in many cases a substantial percentage of a company's generating capacity is used less than 30 days per year.

In the use of water-gas equipment to attain the highest production capacity it is frequently found best to re-form either the refinery byproduct gas or natural gas, rather than to use the conventional coke and gas-oil combination of raw materials. One such scheme for re-forming has, according to reliable figures recently developed, made possible a production of 9,000,000 cu.ft. of 550-B.t.u. gas per 24 hours in a single 11-ft. water-gas machine. This is perhaps three times the productive capacity that it was believed possible to attain in machines of this size only about a decade ago. Obviously when capacities are thus tripled, the unit capital charges, which often amount to much the largest percentage of the cost of peak-load manufacture, are correspondingly cut to one-third.

Another tendency which seemed an outstanding development of water-gas manufacture a year or two ago—namely, the use of heavy fuel oil instead of gas oil for carburetting—has become a less important factor in development, because of the prevailing comparatively low price of all petroleum products. There has been, however, a sufficient use of these new schemes for gas making with heavy oil so that the technique is well established and the process is almost universally recognized as thoroughly satisfactory for any modern machine properly equipped with the minor accessories that make for high efficiency.

Developments indicate that no longer need the gas man dictate with great accuracy as to the kind of petroleum product which he wants. He can take almost anything from refinery byproduct gas, through propane and butane, up to "Bunker C" heavy fuel oil. This is but another evidence of the way in which the petroleum and the gas industries are constantly becoming more intimately interlocked in economic matters.

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Chromium Plating Patent Suit Upheld

THE patent covering a continuous, practical, and commercially successful chromium plating process issued to Prof. Colin G. Fink in 1926, and now owned by the United Chromium, Inc., has been upheld by the District Court of the United States for Connecticut. In a suit claiming infringement brought by the International Silver Co., Judge Thomas said that all claims in the suit are held valid and not inspired by the prior publication or by the prior art and not anticipated by the alleged prior uses. Further, he says, "it follows, therefore, that there may be a decree for the plaintiff for an injunction, reference, and accounting."

NEWS FROM WASHINGTON

By Paul Wooton

Washington Correspondent of Chem. & Met.

CHEMICAL and allied products must contribute about $50,000,000, or 40 per cent, if the $125,000,000 advance in freight rates proposed by the Interstate Commerce Commission becomes effective. This estimate is based upon carload tonnage shipped in the year ended June 30 last and does not include less-than-carload traffic, which also is subject to increases on hauls over 175 miles.

Hit hardest, petroleum and petroleum products will be spared the full effect of increases totaling $13,280,000 by a provision that, when applied, the increased rates shall not exceed the maximum in an upward revision previously prescribed by the Commission to become effective Dec. 3.

Chemical and related products subject to an increase in rates of $3 per car would contribute about $14,600,000. Included in this group are coke, ores and concentrates, pulpwood, and construction materials of various descriptions. Crude petroleum, phosphate rock, sulphur, asphalt, building stone, pig iron and scrap must bear an increase of $6 per car for a total of $5,000,000. An increase of 1c. per 100 lb. affects refined petroleum, oil and gasoline, naval stores, cement, brick and building tile, fertilizer, vegetable-oil cake and meal, and lime. In the aggregate the increase in rates on this group will approximate $20,800,000. This group was specially favored, as all other carload freight must pay an increase of 2c. per 100 lb.

IT IS impossible to segregate all the chemical products that will be subject to the 2c. surcharge, but the total for a dozen of the principal commodities amounts to $10,100,000 and embraces salt, rubber, vegetable oils, sugar and molasses, sewer pipe and drain tile, denatured and wood alcohol, paper, paperboard and roofing materials, sulphuric acid, explosives, paint and varnish, soap and washing compounds, glass and glass containers.

Less-than-carload freight will be subject to an increase of 1c. per 100 lb. on hauls over 175 and including 250 miles; 2c. per 100 lb. beyond 250 miles. Exempting short-haul l.c.l. shipments from a rate increase is expected to prevent any considerable diversion of tonnage to trucks. Otherwise the increases apply to all carload and l.c.l. shipments regardless of length of haul. Through shipments, including those moving on a combination rate, will take only one increase.

Effect of Proposed Freight Rate Increases on Chemical and Allied Products

		(Add 000)
Increased $3 per car: $35,900,000	Coke	$1,100
	Iron ore	2,500
	Non-ferrous ores and concentrates	600
	Other products of mines	1,500
	Construction materials	8,400
	Pulpwood	500
		$14,600
	All other carload freight subject to increase of $3 per car.	21,300
Increased $6 per car: $5,000,000	Phosphate rock	$580
	Pig iron and scrap	1,560
	Building stone	850
	Sulphur	160
	Crude petroleum	1,380
	Asphalt	470
		$5,000
Increased 1c. per 100 lb.: $23,300,000	Naval stores	$100
	Refined petroleum, oil and gasoline	11,900
	Cement	4,300
	Brick and building tile	2,000
	Vegetable-oil cake and meal, including cottonseed	500
	Lime	300
	Fertilizer	1,700
		$20,800
	All other carload freight subject to increase of 1c. per 100 lb.	$2,500
Increased 2c. per 100 lb.: $53,400,000	Salt	$1,140
	Crude rubber	170
	Vegetable oils	600
	Sugar and molasses	2,120
	Sewer pipe and draintile	620
	Industrial alcohol	130
	Paper, paperboard, etc.	3,220
	Sulphuric acid	720
	Explosives	100
	Paint and varnish	130
	Soap and washing compounds	430
	Glass (except plate) and glass containers	720
		$10,100
	All other carload freight increased 2c. per 100 lb	$43,300
L.c.l. freight increased 1c. per 100 lb. beyond 175 and including 250 miles; 2c. per 100 lb. beyond 250 miles		$5,400
Switching charges increased 10 per cent		2,000
		$125,000

A COMPROMISE is looked for that will finally remove Muscle Shoals from the political stage before the 1932 presidential campaign. There is some talk that in order to bring this about, President Hoover will agree to legislation that will let the government "dabble" in fertilizer manufacture. The federal-state commission's recommendations will be in the President's hands before Congress convenes. Its general findings, as announced by S. F. Hobbs, the chairman, several weeks ago, subject to modification later, were that it is "economically feasible and desirable" to operate Muscle Shoals for the production of fertilizer of greater concentration than that which is now available to farmers and that the preference as among prospective lessees should be accorded to a farmer-owned and controlled organization. Such a plan implies government financing of a corporation created by the American Farm Bureau Federation. Whatever plan is finally evolved, the prospect is that the government will be compromised.

J. W. McLaughlin, vice-president of the Carbide & Carbon Chemical Corp. and treasurer of the Manufacturing Chemists' Association, has been appointed by Commissioner Doran to serve on the advisory council of the Bureau of Industrial Alcohol. Mr. McLaughlin will succeed Charles L. Reese, former member of the executive committee of the Manufacturing Chemists' Association, who retired in January, 1931.

The output of industrial alcohol during 1932 has been tentatively placed at 85,000,000 wine gallons, the same figure as the calculated sales for the current year. Under the voluntary agreement by which the distillers, in cooperation with Commissioner Doran, have for several years fixed annual quotas, next year's total may be revised later if necessary to meet actual requirements for anti-freeze or other purposes.

Imposition of a tariff on creosote oil was opposed at a hearing Oct. 30 before the Tariff Commission by British manufacturers, the railroads, and wood preserving plants. They contended that a duty would increase the price of creosote oil. Domestic manufacturers did not appear at the hearing, because they felt that they could not amplify upon the cost data that is in the Commission's hands. It is expected that the Commission will submit to the Senate next January its recommendation for a rate of duty that would compensate for the disparity between domestic and British costs of production. What basis of value will be used by the Commission in determining such costs is not known, as the Commission, since its reorganization a year ago, has not disclosed any information prior to the final reports in its investigations.

Economics Still Center of German Industry's Attention

Drop in Sterling Has Unsettling Effect on Industry

From Our Berlin Correspondent

INDUSTRIAL commodity production in Germany has continued its decline of the past few months. The index of production of the major industries (1928 = 100) dropped from 73.3 in April to 68.1 in August, 1931. At present it is suspended under the low-water mark of the crisis in 1925-26, corresponding to the activity of about 1922 and 1924. Comparing it with the prewar period, there is about 30 per cent less production than in 1913 (including the now lost territory); industrial production at present is on the same level as at the turn of the century, that is 1900-1903. Especially great has been the decline in the commodity market, where the index for August sank to 63.4. The steel industry, together with machinery production and non-ferrous metallurgy, has receded most sharply. More as an explanation than as a consolation, it is found by the Institut für Konjunkturforschung, that the index for world production, with 1928 as 100, is now about 80.8.

In the chemical trade, the crisis of the English pound is developing alarmingly and carrying many industries into confusion. This has been accentuated by the numerous other countries that have also abandoned the gold basis. There is still some hope for export business in the meeting of the International Chamber of Commerce in Paris. Dealers in various countries decline to fulfill contracts closed before the crisis of the pound, and demand fulfillment according to the gold standard. On the other hand, reputable merchants, such as a group in Hamburg, insist that a pound is a pound and demand fulfillment of contracts just as they fulfill their own. According to some experiences in domestic trade, numerous groups have proved willing to transact business, negotiated before the crisis, according to the gold standard, but others try to exploit the situation to an unjustifiable advantage. The question of foreign exchange, of course, has brought all sorts of difficulties. Although domestic prices in general have remained unchanged, export prices are drifting more and more from a pound to a dollar basis, or to a gold-mark basis. An example of this situation is shown in the motor fuel market: reduction in price of 2½ pf. in Berlin is mainly due to calculation of Roumanian benzine on a pound basis, whereas many other companies calculate on a dollar basis. The German quinine convention, another example, decided to abandon the Reichsmark prices altogether and to transact business according to the Dutch gulden, calculable according to the daily exchange. If this example is followed, domestic prices will also be affected by this uncertainty and make the whole situation even more complex and hopeless.

THE Mansfeld Copper Co., employing 7,000 workers, is at the point of shutting down. Outside of Germany, copper production costs have dropped greatly, so that the works of Mansfeld are fairly certainly destined to prove unprofitable. A purely economic viewpoint of this problem, however, does not do full justice to the situation, since copper is necessary for the national defense, in which case Germany would be dependent on Mansfeld for copper supplies during a blockade. Therefore, it may prove advisable to maintain this concern as a matter of national economy.

At Basel, the Alliance Aluminum Co., A.G., has been founded by French, English, German, Swiss, and Canadian aluminum producers, and probably includes the Norwegian companies. The purpose of this new company is the advancement and expansion of aluminum consumption, perhaps also a sort of reserve financing. It is widely assumed here that this is in preparation for a world aluminum pact.

German petroleum remains in activity by virtue of 50 new drillings by the Burbach group at Thüringen. The operations, which are carried on at a depth of 1,000 meters under the potash basin, do not conflict with the regular extraction of the potash. The oil found here contains about 25 per cent gasoline; it is shipped to the Leunawerke for processing some 80 km. away, and a direct pipe line is planned. The German gasoline market as well as the lubricating field, is being invaded more and more by Russia. Its participation in Germany's gasoline import has risen from 7.2 per cent in 1927 to 11.7 in 1930 and 18.6 this year, now surpassing both Roumania and Persia in importance. In the lubricating field, Russia is advancing at the expense of the United States; its participation has risen from 18.3 per cent in 1927 to 20.8 in 1930 and 29.5 in the current year.

THE Acetic Acid Syndicate has been so seriously menaced by outsiders that its dissolution is imminent. Although, with extensive European-American cooperation in the active carbon industry, with cooperation of the I.G. and the Metallgesellschaft, a stable condition in the related field of acetic acid seemed assured, the strong underbidding in acetic acid prices by American producers has brought matters to a point where such companies as the Lonzawerk in Baden are erecting independent plants. The company mentioned is no longer satisfied with its quota.

The glass works of Schott & Co., at Jena, are installing sulphuric acid concentration plants with a new quartz material called Dioxsil. The material is worked into dishes of a special shape which are placed in a heated tower, where the thin acid is concentrated as it flows from the upper levels downward. If sulphur trioxide forms through overheating, this is again dissolved as the gases pass through the dishes into the acid. In this connection it is felt that the workability of Dioxsil should be favorable to manufacturers of various larger chemical apparatus.

The corrosion problem, with reference to underground pipe lines, is solved to some degree by the products Herolith and Tornesit. The latter is a rubber derivative which is applied in thin or thick coatings on the object to be protected. It is stable to various common reagents such as hydrogen sulphide, tetralin, benzene; against most acids in salt, and even steam up to 120 deg. C. and dry heat up to 135 deg. Herolith is an artificial resin which is used in a similar manner. Both coatings stick to the metal surfaces very firmly, and can be removed only with a great deal of trouble, but at the same time they are flexible enough to conform to any deformation of the metal. Pipes with these coatings are manufactured by the Mannesmann-Rohrenwerke, Düsseldorf; for other purposes the material is made by the Herold A.G., Hamburg. Herolith probably shows the greater durability; it is unaffected by most solutions and withstands temperatures up to 150 deg. C. in the case of steam and about 200 deg. of dry heat. Injuries of the coating arising from such causes as welding can immediately be repaired by reapplication of a liquid coating.

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New Method for Phosphoric Acid Analysis

ONE of the most important subjects to come before the annual meeting of the Association of Official Agricultural Chemists, held at Atlanta, Ga., Nov. 10, was the consideration of the method of analysis of fertilizer containing ammoniated superphosphate. Under the old method of analysis it was found that the entire quantity of available phosphoric acid content of fertilizers was not properly determined. At the annual meeting held a year ago a new method of analysis was proposed and has been tried out in the intervening period. At the Atlanta meeting the new method was adopted as official. This action is regarded as important not only because it effects a saving for the industry but also because it will permit a larger use of ammonia in fertilizer manufacture.

Officers of the association for the coming year will be A. E. Paul, Chicago, president; J. W. Kellogg, Harrisburg, Pa., vice-president; W. W. Skinner, Washington, secretary-treasurer.

Sulphur Plant Started In Louisiana

FORMAL breaking of ground for a sulphur production plant was effected recently at Abbeville, La., by the Jefferson Lake Oil Co. with ceremonies in which state and local interests participated. The dedication was on the plant site on the shore of Lake Peigneur, and was attended by hundreds of local residents and stockholders of the company.

The lease obtained by the company from the State of Louisiana covering the bed of Lake Peigneur was effected under the established laws and at a time when expert opinion considered the Five Islands, of which Lake Peigneur is one, not worth while for mineral development other than salt, declared Arthur Barba, Sr., its president, in his dedication address. Despite the adverse opinion, the company went ahead in large expenditures that revealed the existence of a sulphur deposit, a much larger salt dome than was thought to exist, and evidence of oil, he said.

The company has expended approximately $500,000 in preliminary work on Lake Peigneur, outlining the sulphur deposit to be mined. Its initial plant will have a minimum capacity of 100,000 tons and occupy 85 acres. The main building will be 70x100 ft. and other structures will include a warehouse, an office building, an 80-ft. water tower of 30,000-gal. capacity, a 15,000-bbl. oil tank, 50 acres of sulphur vats of 1,000,000-ton capacity, two 8-in. water wells, and a quadruple 6,000-ft. pipe line from the plant to the deposit. It will be completed in four months.

❖

Government Aids French Nitrogen Company

A REPORT from our assistant trade commissioner at Paris states that the Toulouse nitrogen plant operated by the Office National Industriel de l'Azote was allocated by law of June 30, 1930, 140,000,000 francs, of which 90,000,000 francs was ear-marked for the construction of a nitric-acid plant and the balance was intended for back debts and operating capital. A decline in domestic consumption, together with world overproduction of nitrogen and a fall in prices, has led to the accumulation of large stocks at Toulouse notwithstanding reduced production schedules. The Office National received from the state up to the end of December, 1930, a total of 325,000,000 francs, excluding the special allotment for the construction of the new nitric-acid plant. This sum was apparently insufficient, for the total disbursements up to March 31, 1931, reached 378,000,000 francs.

Parliament was recently called upon to consent to a new appropriation of 50,000,000 francs in order to permit the Toulouse plant to continue operations on a fixed schedule of 80,000 metric tons of ammonium sulphate annually. This figure was agreed to after long and delicate negotiations between the government and private industrialists.

❖

German Company to Hold Electro-Filter Licenses

THE German national register of business concerns has recently recorded the incorporation of "Siemens-Lurgi-Cottrell-Elektrofilter-Gesellschaft mit beschränkter Haftung für Forschung und Patentverwertung." A "Gesellschaft mit beschränkter Haftung" is a form of corporation which corresponds somewhat to the limited liability partnership as defined by the federal corporation law of the United States. The object of the new company is "research and commercialization of patents," and more particularly of those dealing with the cleaning of air, gases, and insulating liquids by the electrical method, as exemplified by the electro-filter Siemens-Lurgi-Cottrell, by Lurgi-Cottrell process, and the Siemens process.

❖

Italgas Will Dispose of Acna Interests

PLANS have been made by the Societa Italiana per IL Gas (Italgas), of Rome, Italy, for the sale of its subsidiary, the Aziende Chimiche Nazionali Associate, otherwise known as Acna, a chemical company which it is stated has been operating at a loss. The parent company is debtor under the Italian agreement securing series D 7 per cent bonds of International Power Securities Corp. and subsequent to the sale of Acna would cancel $530,000 of the series D bonds.

The Bankers Trust Co. of New York is trustee for the bonds and requests that a majority of the bondholders consent to the sale. With this consent given Italgas would surrender $530,000 bonds for cancellation, reducing the outstanding amount to $3,665,000 of an original issue of $5,000,000 brought out in 1926. Banca Commerciale Italiana would guarantee the remaining bonds.

❖

Paint and Varnish Trade Will Meet in Chicago

THE sixth annual convention of the American Paint and Varnish Manufacturers' Association will be held at the Drake Hotel, Chicago, Dec. 1-3. The convention will open at noon on Dec. 1 with a luncheon and annual meeting of the educational bureau. The president's dinner to the board of directors will be held that evening. On Dec. 2, the board of directors will convene and this will be followed by the first general business session. Presentation of papers, reports of committees, and election of officers will form the basis of sessions through the afternoon of Dec. 3.

French Foreign Trade Affected by Exchange

From Our Paris Correspondent

AS EXPECTED, the French ministers' visit to Berlin has not yet had appreciable results, the French and German points of view still remaining too far apart to enable the drawing of a Franco-German agreement. A Franco-German board has been elected, however; its members are either well known business men in financial or industrial circles or are specialists of the governmental staff. This board will survey commercial difficulties arising between the two countries, one being the readjustment of the Franco-German customs agreement of 1927, which has favored German exports to France and has been detrimental to the home industry.

The fall of sterling on the world market has already had a most damaging effect on Franco-British commerce, in spite of the immediate financial assistance given to the Bank of England. The Lyons silk and rayon trade among others is particularly affected as British buyers of Lyons silks, according to an established custom, always draw their contracts in terms of English money. The chemical trade also is affected; several British chemical products such as copper sulphate, ammonia salts, menthol, thymol, etc., being cheaper and imported in large quantities, have made prices fall. Moreover, as Great Britain probably will become a protectionist country and raise present British custom tariffs, it is believed that Franco-British commerce will suffer.

The French market is favorable to foreign shippers, not only on account of the steadiness of the French franc but also because manufacturers having established cost prices in sterling and reichmarks can compete with French manufacturers who have established their cost prices in francs. The result is that French manufacturers are now in a very unfavorable position, not only in the export market but also in their home market. A striking example is given by the following figures: during the last nine months French exports have gone down nine billion francs, while imports have declined only five billion francs; in fact the 1931 commercial balance of France compared with the 1930 balance during the same period has shrunk ten billion francs.

It is hoped in France that tangible results will follow the Hoover-Laval interview, but without being over-pessimistic it should be remembered that fundamental differences exist between the general economy of both countries. American methods, such as low-priced mass sales and high salaries for instance, cannot be applied to France.

The world crisis has severely disturbed the porcelain industry, whose main centers are Limoges and Vierzon. Most of the factories of these towns have reduced their working hours by 50 per cent and several old-established and world-renowned firms are in difficulties.

MEN
IN CHEMICAL ENGINEERING

H. C. PARMELEE was elected vice-president of the McGraw-Hill Publishing Co., effective Nov. 2, and continues to serve as its editorial director. Three years ago, Nov. 1, 1928, he relinquished the editorship of *Chem. & Met.*, which he had held since 1918, to assume the general editorial direction of all McGraw-Hill publications. He also is chairman of the advisory committee for the Chemical Engineering Series of McGraw-Hill text and reference books. Dr. Parmelee was president of the Electrochemical Society in 1924; secretary of the American Institute of Chemical Engineers, 1927 to 1929; and since 1924 has served as chairman of the institute's committee on chemical engineering education.

H. C. PARMELEE

WILLIAM F. TALBOT, formerly of the University of Iowa and later of the experimental station of the duPont company, has joined the staff of Gustavus J. Esselen in Boston.

AUGUST V. GRAF, formerly chief chemical engineer of the Chain of Rocks Plant of the St. Louis Water Works, now has general supervision of this plant and all purification for the city.

HARRY J. HOSKING, formerly of Roessler & Hasslacher Chemical Co., Niagara Falls, N. Y., has joined the staff of Foster D. Snell, Inc., Brooklyn.

GEORGE STERN, formerly chemical engineer on the market research staff of the Barrett Co., has joined the Arthur R. Maas Chemical Co. at Los Angeles.

H. K. BENSON, head of the department of chemical engineering and industrial chemistry at the University of Washington, Seattle, Wash., is now resident in Washington, D. C., as chairman of the division of chemistry and chemical technology of the National Research Council for the present year.

H. K. BENSON

CHARLES F. BURGESS of the Burgess Laboratories, Madison, Wis., has received the award of the Perkins medal for 1932 in recognition of his achievements in electrochemistry. The medal will be presented in New York on Jan. 8, at a joint meetings of the chemical societies. Dr. Burgess, a native of Wisconsin 58 years ago, was graduated from Wisconsin University in 1895 and stayed there as a member of the faculty until 1913, when he engaged in numerous private electrochemical enterprises, including the formation of the Burgess Co., in Hoboken, N. J.

W. C. HEATH, formerly vice-president in charge of engineering at the Fairbanks-Morse Co., Beloit, Wis., has been elected vice-president in charge of research, engineering, and factory production of the A. O. Smith Corp. at Milwaukee, Wis.

KENNETH A. KOBE, of the University of Minnesota, is acting as instructor of chemical engineering at the University of Washington, Seattle, in the absence of Prof. H. K. Benson.

H. W. CREMER has been appointed honorary secretary of the Institution of Chemical Engineers, London, in the place of the late Prof. H. W. Hinchley.

OBITUARY

ORVILLE F. BRYANT, chemical engineer and technical adviser to the Canadian Pulp and Paper Association, died suddenly at Montreal on Oct. 27, 44 years old. He was a graduate of the University of New Hampshire and soon became recognized in pulp and paper technology. After being chief of the pulp and paper division of the Forest Products Laboratories of Canada, Mr. Bryant was permanently concerned in the establishing of the Pulp and Paper Research Institute, of which he was appointed technical adviser in 1930.

BRUCE C. DAVEY, vice-president of the Denver Equipment Co. and one of the founders of the company, died on Nov. 4 at Chicago while on a business trip.

SAMUEL W. STRATTON, chairman of the corporation of the Massachusetts Institute of Technology, died of heart attack on Oct. 18 at his home in Boston at the age of 70. Dr. Stratton had recently returned from the Faraday celebration in England and apparently was in the best of health. It was while Dr. Stratton was teaching chemistry and physics that he evolved the idea which eventuated in the national Bureau of Standards. He brought it to the attention of the Secretary of the Treasury in 1900, and in the following year Congress acted favorably. Dr. Stratton then became first head of the Bureau and remained until his resignation, in 1923, to become president of Massachusetts Institute of Technology. During the past year he had made plans for several large technical projects at that school.

MARK WALKER, one of the earliest chemists of southern California, died on Sept. 30 at his home in South Pasadena. Mr. Walker was born on April 24, 1870, in Glasgow, Scotland, coming to the United States at an early age. He was a graduate of the University of Arizona in 1897. Later, he spent a year teaching at the University of Redlands, and then took charge of the laboratory and chemical research of the Pacific Roessler & Hasslacher Co.

CALENDAR

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, fall meeting, Atlantic City, N. J., Dec. 9-11.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, annual meeting, New York, Nov. 30-Dec. 4.

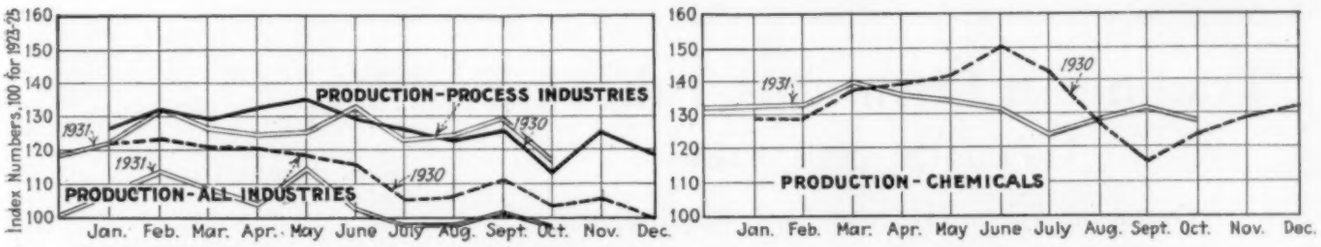
ELECTROCHEMICAL SOCIETY, spring meeting, Baltimore, April 21-23.

MATERIALS HANDLING EXPOSITION, first meeting, New York City, indefinitely postponed.

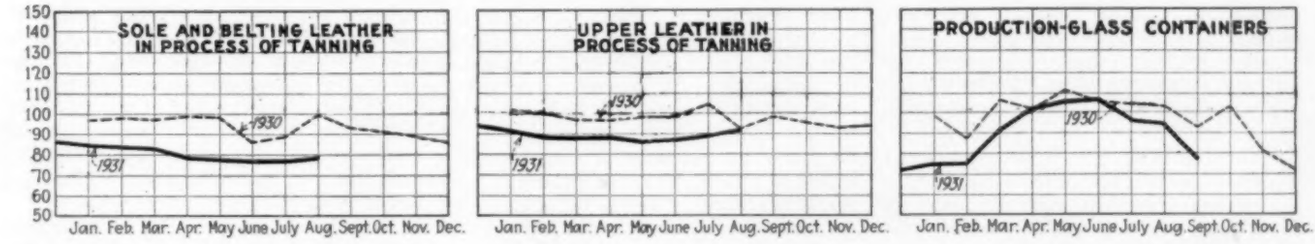
TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY, New York, third week of February.

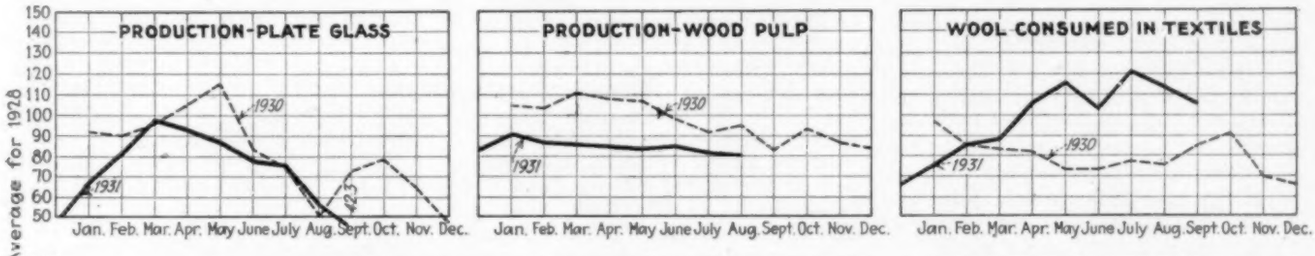
THIRD INTERNATIONAL CONFERENCE ON BITUMINOUS COAL, Pittsburgh, Nov. 16-21.

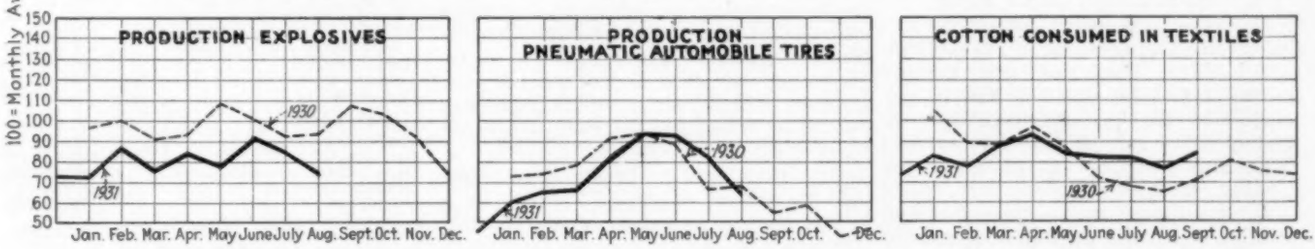
ACTIVITY IN PRODUCING AND CONSUMING INDUSTRIES

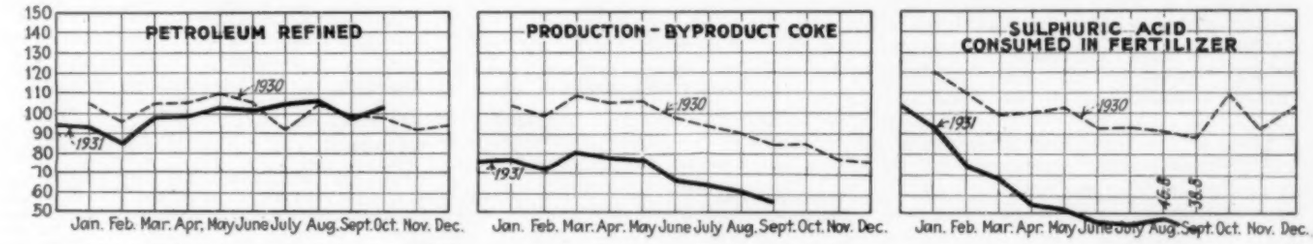


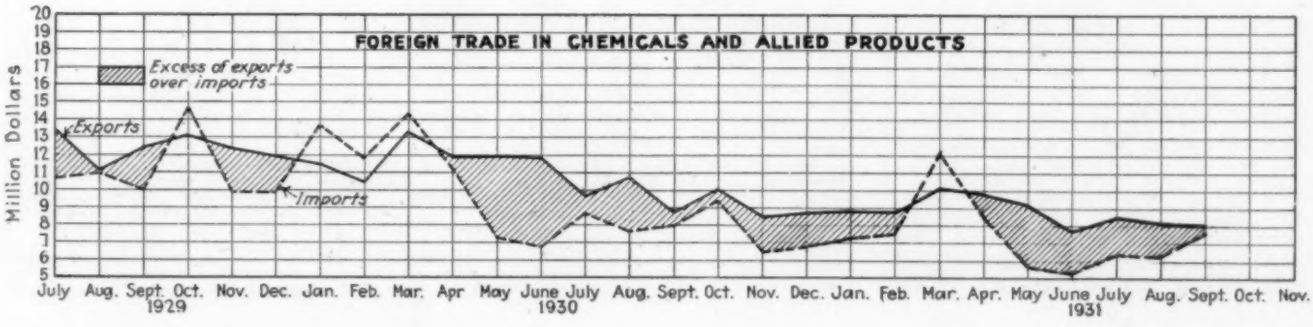
Based on electrical power consumption, data supplied by Electrical World


SOLE AND BELTING LEATHER IN PROCESS OF TANNING
UPPER LEATHER IN PROCESS OF TANNING
PRODUCTION-GLASS CONTAINERS
1930
1931
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.




PRODUCTION EXPLOSIVES
PRODUCTION PNEUMATIC AUTOMOBILE TIRES
COTTON CONSUMED IN TEXTILES
1930
1931
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.


PETROLEUM REFINED
PRODUCTION - BYPRODUCT COKE
SULPHURIC ACID CONSUMED IN FERTILIZER
1930
1931
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.


Million Dollars
FOREIGN TRADE IN CHEMICALS AND ALLIED PRODUCTS
Excess of exports over imports
Exports
Imports
July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov.
1929
1930
1931

MARKET CONDITIONS AND PRICE TRENDS

Trading in Chemicals Takes on Greater Activity

Consuming Industries Slow to Cover Requirements
Quarter Ended Sept. 30

INTEREST in chemical products was materially increased in the last few weeks and call for contract deliveries showed marked improvement as well as demand for spot stocks. Various consuming industries were in the market as a result of larger manufacturing operations. Placing of contracts for delivery over next year is still backward. However, it is reported that buyers have contracted freely in such products as bleaching powder, liquid chlorine, and bicarbonate of soda, the contract prices showing no change from the figures recently quoted. Prices for aqua and anhydrous are expected to be announced in two weeks, with the probability that they will be the same as for 1931 contracts. Sal ammoniac has sold in fair quantities for 1932 delivery, with the white material unchanged in price and slight concessions given on the gray, the new price being 5¼c. per lb.

The upturn in prices for grains has had a stimulating effect. The outlook for fertilizer chemicals was notably improved and tag sales in the 16 tag sale states for October were approximately 90 per cent of those for October, 1930, and 94 per cent of those for October, 1929.

The position of naval stores also was greatly improved during the month. Receipts at southern markets have been smaller and the industry is working to establish greater harmony between supply and demand. Prices at present show a marked tendency to advance.

ONE of the important developments of the month consisted in an announcement that the Standard Chromate Company, Inc., had opened a new plant at Painesville, Ohio. The plant is reported to be in volume production on bichromate of soda. The sponsors of the new enterprise claim for their process a completely mechanical method of ore reduction. Following the announcement that a new producer had entered the field, a decline of one-half cent per pound for bichromate of soda and bichromate of potash, was put into effect by the old producers. Some years ago the bichromate market, especially during the contracting period, was highly competitive but production gradually simmered down to three producers and in recent years prices have been fairly well stabilized. The new development promises to revive some of the former conditions and already consumers have been aided by the increase in production.

Considerable interest also was attracted by the announcement that E. I. du Font de Nemours & Co. had perfected a process for the production of synthetic rubber. The process calls for the controlled polymerization of chloroprene and chloroprene is made by the catalytic polymerization of acetylene to mono-vinylacetylene, which is then treated with hydrogen chloride to produce chloroprene. This chemical result has led to the selection of "Duprene" as the trade name for the new rubber.

In the alcohol trade the most important occurrence of the month was the establishment of 85,000,000 wine gallons as the quantity of industrial alcohol to be produced in 1932. At a conference held between concerns which manufacture approximately 90 per cent of the permitted industrial alcohol and the prohibition unit, it was agreed that permits would be issued for the manufacture of approximately the same quantity of alcohol next year as was produced during the current year.

An interesting announcement on the authority of our commercial attaché at Tokyo says that the Department of Commerce and Industry and the Department of Agriculture and Forestry in Japan have agreed upon an import license system to govern the importation of sulphate of ammonia into that country. Similar regulations for soda ash are possible.

Latest available statistics show that demand for chemicals has held up well in the textile, rayon, and oil refining trades. Glass manufacturers in the last three months have cut down their requirements. Output of plate glass declined from 6,088,326 sq.ft. in August to 4,610,930 sq.ft. in September. The tire trade also reported lessened activities. Production and consumption of vegetable oils in the third quarter of the year compared unfavorably with that for the corresponding period of last year.

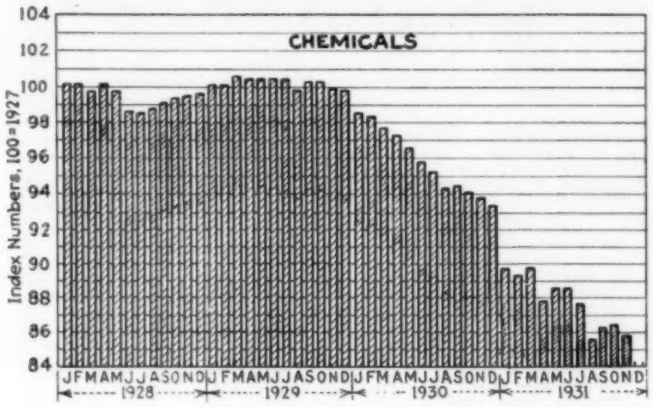
Statistics of production and consumption for September, with comparisons for last year, follow:

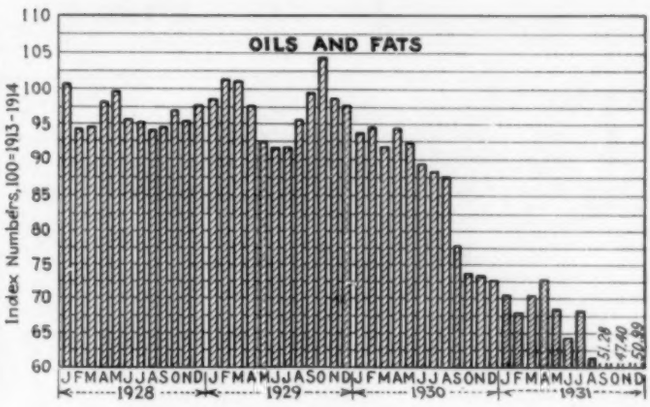
	Sept., 1931	Sept., 1930
Production		
Arsenic, crude, ton	994	2,077
Arsenic, refined, ton	1,252	1,101
Alcohol, ethyl, 1,000 pr. gal	12,952	14,299
Alcohol, ethyl, withdrawn for denaturization, 1,000 pr. gal	13,076	12,615
Automobiles—cars, no.	109,087	175,496
Trucks, no.	31,338	44,223
Taxis, no.	141	930
Byproduct coke, 1,000 tons	2,310	3,376
Cottonseed oil, crude, 1,000 lb	136,699	170,364
Cottonseed oil, ref., 1,000 lb	63,989	103,476
Glass containers, 1,000 gr	1,820	2,460
Sulphuric acid, produced by fertiliser industry, ton	102,632	172,529
Rosin, wood, bbl.	25,058	38,293
Turpentine, wood, bbl.	3,797	6,573
Pine oil, gal.	172,539	229,238
Consumption		
Cotton, bales	463,704	393,390
Silk, bales	53,819	55,649
Wool, 1,000 lb. grease equivalent	47,548	38,083
Fertilizer consumed in South, 1,000 tons	91	136
Sulphuric acid consumed by fertiliser industry, ton	78,606	180,181
Paint, varnish and lacquer products, sales, value $1,000	$21,921	$28,177
Plastic, cold-water paints and calcimines, sales, 1,000 lb	5,610	4,578

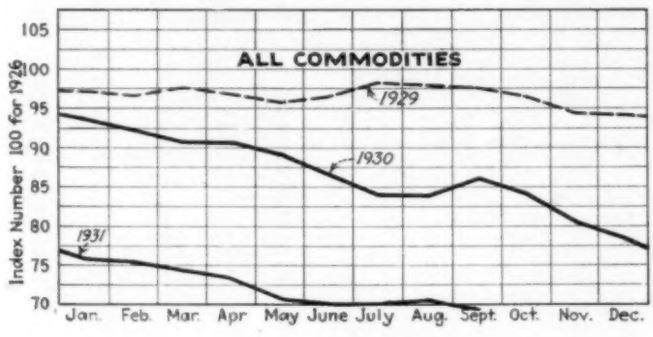
Factory Production and Consumption of Vegetable Oils, Quarter Ended Sept. 30

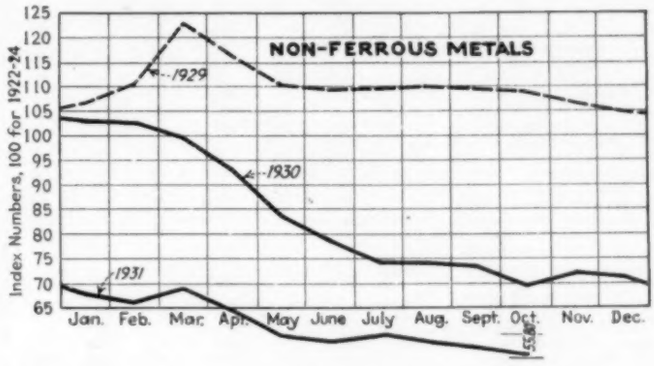
	Production		Consumption	
	1931 Lb.	1930 Lb.	Lb.	Lb.
Cottonseed, crude	160,983,737	238,750,677	99,470,896	171,982,423
Cottonseed, refined	91,966,959	158,167,124	232,420,109	323,521,464
Peanut, crude	1,134,243	2,750,535	2,357,147	2,751,189
Peanut, refined	2,096,240	2,330,798	2,546,232	2,549,508
Coconut, crude	61,387,627	85,068,486	137,729,969	150,752,555
Coconut, refined	68,682,102	69,312,892	78,496,371	76,571,959
Corn, crude	25,291,850	28,776,328	25,335,154	29,101,988
Corn, refined	21,807,440	23,252,550	6,878,377	2,559,602
Soya bean, crude	8,390,902	1,220,439	11,796,177	4,183,240
Soya bean, refined	8,667,208	1,817,939	4,977,467	2,169,746
Olive, edible	.....	.....	647,838	909,679
Olive, inedible	.....	.....	2,123,520	1,353,153
Sulphur oil	.....	.....	10,336,376	9,966,795
Palm kernel, crude	6,463,447	.....	13,120,631	12,120,696
Palm kernel, refined	6,170,308	3,117,078	6,106,041	2,643,064
Rapeseed	.....	.....	2,185,900	3,054,279
Linseed	141,204,905	108,236,266	70,503,636	80,359,123
China wood	.....	.....	18,362,074	19,070,724
Castor	12,084,806	10,046,697	4,403,744	4,343,102
Palm	.....	.....	54,118,634	60,343,000
Sesame	23,839,876	.....	25,751,339	.....
Sunflower seed	.....	.....	8,714,481	.....
All other	83,487	7,774,425	1,237,812	8,551,293
Totals	640,255,137	740,622,234	819,619,925	968,858,492

CHEM. & MET. *Weighted Indexes of* PRICES









Firm Tone Underlies Market For Chemicals

ALTHOUGH the weighted index for chemical prices was lowered during the month, the market in general showed a resistance to further declines. Soft spots are noted in a few cases and undoubtedly sales pressure will be in evidence over the remainder of the year, so far as some commodities are concerned, yet there is no indication that consumers of alkalis will be able to place contracts for 1932 at anything like the low levels which ruled during the contracting period for 1931. Alcohol likewise is presenting a strong front and present quotations do not appear to have been shaded in actual transactions.

The recovery in values for grains and other commodities also has a wide psycological effect and has added to the belief that the low level of prices has been passed, for the present at least.

Average prices for metals were unusually low in October, but the trend is now upward and a corresponding strengthening in values for metal salts is expected to follow.

Commodity price indexes covering diversified industries, after a period of slight fluctuations, have turned upward and, as in the case of chemicals, it is pointed out that stocks in the hands of distributors and consumers are very low, and with evidence of renewed activity in buying interest, underlying conditions are favorable to a general hardening of commodity prices.

Instability of foreign exchange has complicated the outlook for export trade and has brought out keener competition from some imported chemicals.

The most important influence on values, however, is found in the position of consuming industries. Recent price advances have been based largely on an increase in demand. Improvement in manufacturing operations, if sustained, will be a guarantee against declines and the low rate of activities over a long period would seem to justify the opinion that a larger movement of raw materials is in prospect.

Vegetable oils and fats, almost without exception, are commanding higher prices than was the case a month ago. With stocks large and buying inactive, values had gradually sunk to an unusually low plane and buyers were able to dictate their own terms. As prices in general firmed up, oils began to follow suit, and this in turn brought out a more active trading movement. In most cases, current quotations for oils and fats are still below pre-war levels.

Chem. & Met Weighted Index of Chemical Prices

Base = 100 for 1927

This month	**85.98**
Last month	86.37
November, 1930	93.82
November, 1929	99.95

Acetic acid, sulphate of ammonia, and bichromates were lower in price and influenced the downward movement of the index number. Spirits of turpentine showed a good net advance with the naval stores industry improving.

Chem. & Met Weighted Index of Prices for Oil and Fats

Base = 100 for 1927

This month	**50.99**
Last month	47.40
November, 1930	73.09
November, 1929	98.51

A sharp upturn to the weighted number for vegetable oils was led by crude cottonseed, linseed, and china wood oils. Crude menhaden oil, which sold at very low levels a month ago, also gained in value. Tallow and other animal fats closed in a firmer position.

CURRENT PRICES *in the* NEW YORK MARKET

THE following prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to Nov. 12.

Industrial Chemicals

	Current Price	Last Month	Last Year
Acetone, drums, lb.	$0.10 -$0.11	$0.10 -$0.11	$0.11 -$0.12
Acid, acetic, 28%, bbl., cwt.	2.50 - 2.75	2.60 - 2.85	2.73 - 2.88
Glacial 99%, tanks	8.10 -	8.98 -	8.98 -
drs	8.35 - 8.60	9.23 - 9.48	11.01 -
U. S. P. reagent, c'bys	8.85 - 9.10	9.73 - 9.98	9.73 - 9.98
Boric, bbl., lb.	.06½- .07	.06½- .07	.06½- .07
Citric, kegs, lb.	.35 - .36	.35 - .36	.46 - .47
Formic, bbl., lb.	.10 - .11	.10 - .11	.10 - .11
Gallic, tech., bbl., lb.	.50 - .55	.50 - .55	.50 - .55
Hydrofluoric 30% carb., lb.	.06 - .07	.06 - .07	.06 - .07
Lactic, 44%, tech., light, bbl., lb.	.11¼- .12	.11¼- .12	.11¼- .12
22%, tech., light, bbl., lb.	.05½- .06	.05½- .06	.05½- .06
Muriatic, 18° tanks, cwt.	1.00 - 1.10	1.00 - 1.10	1.00 - 1.10
Nitric, 36°, carboys, lb.	.05 - .05½	.05 - .05½	.05 - .05½
Oleum, tanks, wks., ton	18.50 -20.00	18.50 -	18.50 -20.00
Oxalic, crystals, bbl., lb.	.11 - .11½	.11 - .11½	.11 - .12
Phosphoric, tech., c'bys., lb.	.08½- .09	.08½- .09	.08½- .09
Sulphuric, 60° tanks, ton	11.00 -11.50	11.00 -11.50	11.00 -11.50
Tannic, tech., bbl., lb.	.23 - .35	.23 - .35	.35 - .40
Tartaric, powd., bbl., lb.	.26½- .27½	.26½- .27½	.33 - .34
Tungstic, bbl., lb.	1.40 - 1.50	1.40 - 1.50	1.40 - 1.50
Alcohol, ethyl, 190 p'f., bbl., gal.	2.33 -	2.33 -	2.63 - 2.71
Alcohol, Butyl, tanks, lb.	.14½-	.15½-	.16½- .17
Alcohol, Amyl	-	-	-
From Pentane, tanks, lb.	.203-	.203-	.236-
Denatured, 188 proof			
No. 1 special dr., gal.	.28 -	.28 -	.40 -
No. 5, 188 proof, dr., gal.	.28 -	.28 -	.40 -
Alum, ammonia, lump, bbl., lb.	.03½- .04	.03½- .04	.03½- .04
Chrome, bbl., lb.	.04½- .05	.04½- .05	.05½- .06
Potash, lump, bbl., lb.	.03¼- .04	.03¼- .04	.03 - .03¼
Aluminum sulphate, com., bags, cwt.	1.25 - 1.40	1.25 - 1.40	1.40 - 1.45
Iron free, bg., cwt.	1.90 - 2.00	1.90 - 2.00	1.90 - 2.00
Aqua ammonia, 26°, drums lb.	.02½- .03	.02½- .03	.03 - .04
tanks, lb.	.02½- .02¾	.02½- .02¾	.02½- .02¾
Ammonia, anhydrous, cyl., lb.	.15½- .15¾	.15½- .15¾	.15½-
tanks, lb.	.05½-	.05½-	.05½-
Ammonium carbonate, powd. tech., casks, lb.	.10½- .11	.10½- .11	.10½- .11
Sulphate, wks., cwt.	1.10 -	1.30 -	1.70 -
Amylacetate tech., tanks, lb., gal.	.16½-	.16½-	.222-
Antimony Oxide, bbl., lb.	.08 - .09	.08 - .09	.09 - .10
Arsenic, white, powd., bbl., lb.	.04 - .04½	.04 - .04½	.04 - .04½
Red, powd., kegs, lb.	.09 - .10	.09 - .10	.09 - .10
Barium carbonate, bbl., ton	56.50 -58.00	56.50 -58.00	58.00 -60.00
Chloride, bbl., ton	63.00 -65.00	63.00 -65.00	64.00 -70.00
Nitrate, cask, lb.	.07 - .07½	.07 - .07½	.07 - .07½
Blanc fixe, dry, bbl., lb.	.03½- .04	.03½- .04	.03½- .04
Bleaching powder, f.o.b., wks., drums, cwt.	2.00 - 2.10	2.00 - 2.10	2.00 - 2.10
Borax, grain, bags, ton	50.00 -57.00	50.00 -57.00	50.00 -57.00
Bromine, cs., lb.	.36 - .38	.36 - .38	.45 - .47
Calcium acetate, bags	2.00 -	2.00 -	2.00 -
Arsenate, dr., lb.	.06 - .07	.06 - .07	.07 - .08
Carbide drums, lb.	.05 - .06	.05 - .06	.05 - .06
Chloride, fused, dr., wks., ton	20.00 -	20.00 -	20.00 -
flake, dr., wks., ton	22.75 -	22.75 -	22.75 -
Phosphate, bbl., lb.	.08 - .08½	.08 - .08½	.08 - .08¼
Carbon bisulphide, drums, lb.	.05 - .06	.05 - .06	.05 - .06
Tetrachloride drums, lb.	.06½- .07	.06½- .07	.06½- .07
Chlorine, liquid, tanks, wks., lb.	.01½-	.01½-	.024-
Cylinders	.04 - .06	.04 - .06	.04½- .06
Cobalt oxide, cans, lb.	1.35 - 1.45	1.35 - 1.45	2.10 - 2.25
Copperas, bgs., f.o.b. wks., ton	13.00 -14.00	13.00 -14.00	13.00 -14.00
Copper carbonate, bbl., lb.	.08½- .18	.08½- .18	.09 - .18
Cyanide, tech., bbl., lb.	.39 - .44	.41 - .46	.45 - .46
Sulphate, bbl., cwt.	3.40 - 3.50	3.40 - 3.50	3.95 - 4.25
Cream of tartar, bbl., lb.	.21½- .22	.21½- .22	.24½- .26
Diethylene glycol, dr., lb.	.14 - .16	.14 - .16	.14 - .16
Epsom salt, dom., tech., bbl., cwt.	1.70 - 2.00	1.70 - 2.00	1.75 - 2.00
Imp., tech., bags, cwt.	1.15 - 1.25	1.15 - 1.25	1.15 - 1.25
Ethyl acetate, drums, lb.	.06½-	.06½-	.094-
Formaldehyde, 40%, bbl., lb.	.06 - .07	.06 - .07	.07½- .08
Furfural, dr., contract, lb.	.10 - .15	.10 - .12	.10 - .12
Fusel oil, crude, drums, gal.	1.10 - 1.20	1.10 - 1.20	1.30 - 1.40
Refined, dr., gal.	1.80 - 1.90	1.80 - 1.90	1.90 - 2.00
Glaubers salt, bags, cwt.	1.00 - 1.10	1.00 - 1.10	1.00 - 1.10
Glycerine, c.p., drums, extra, lb.	.11½- .12	.11½- .12	.13 - .14
Lead:			
White, basic carbonate, dry casks, lb.	.07½-	.07½-	.07½-
White, basic sulphate, sck., lb.	.07 -	.07 -	.07½-
Red, dry, sck., lb.	.07½-	.07½-	.08½-
Lead acetate, white crys., bbl., lb.	.11 - .12	.11 - .12	.11½- .12
Lead arsenate, powd., bbl., lb.	.10 - .14	.10 - .14	.13 - .14
Lime, chem., bulk, ton	8.50 -	8.50 -	8.50 -
Litharge, pwd., csk, lb.	.06½-	.06½-	.07½-
Lithophone, bags, lb.	.04½- .05	.04½- .05	.05½- .06½
Magnesium carb., tech., bags, lb.	.06 - .06½	.06 - .06½	.06 - .06½
Methanol, 95%, tanks, gal.	.33 -	.33 -	.38 -
97%, tanks, gal.	.34 -	.34 -	.39 -
Synthetic, tanks, gal.	.35½-	.37½-	.40½- .45
Nickel salt, double, bbl., lb.	.10½- .11	.10½- .11	.13 - .13½
Single, bbl., lb.	.10½- .11	.10½- .11	.13 - .13½
Orange mineral, csk., lb.	.09½-	.09½-	.10½-
Phosphorus, red, cases, lb.	.42 - .44	.42 - .44	.42 - .44
Yellow, cases, lb.	.31 - .32	.31 - .32	.31 - .32
Potassium bichromate, casks, lb.	.08½- .09	.09 - .09½	.09 - .09½
Carbonate, 80-85%, calc., csk., lb	.05 - .05½	.05½- .06	.05½- .06
Chlorate, powd., lb.	.08 - .08½	.08 - .08½	.08½- .09
Cyanide, cs., lb.	.55 - .57	.55 - .57	.52 - .55
First sorts, csk., lb.	.08½- .09	.08½- .09	.08½- .09
Hydroxide (c'stic potash) dr., lb.	.06½- .06¾	.06½- .06¾	.06½- .06¾
Muriate, 80% bgs., ton	37.15 -	37.15 -	37.15 -
Nitrate, bbl., lb.	.05½- .06	.05½- .06	.06 - .07½
Permanganate, drums, lb.	.16 - .16½	.16 - .16½	.16 - .16½
Prussiate, yellow, casks, lb.	.18½- .19½	.18½- .19	.18½- .19
Sal ammoniac, white, casks, lb.	.04½- .05	.04½- .05	.047- .05
Salsoda, bbl., cwt.	.90 - .95	.90 - .95	.90 - .95
Salt cake, bulk, ton	16.00 -18.00	16.00 -18.00	15.00 -18.00
Soda ash, light, 58%, bags, contract, cwt.	1.15 -	1.15 -	1.32 -
Dense, bags, cwt.	1.17½-	1.17½-	1.35 -
Soda, caustic, 76%, solid, drums, contract, cwt.	2.50 - 2.75	2.50 - 2.75	2.90 - 3.00
Acetate, works, bbl., lb.	.05 - .06	.05½- .05¾	.04 - .05
Bicarbonate, bbl., cwt.	1.85 - 2.00	1.85 - 2.00	2.00 - 2.25
Bichromate, casks, lb.	.06½- .07	.07 - .07½	.07 - .07½
Bisulphate, bulk, ton	14.00 -16.00	14.00 -16.00	14.00 -16.00
Bisulphite, bbl., lb.	.03½- .04	.03½- .04	.03½- .04
Chlorate, kegs, lb.	.05½- .07½	.05½- .07½	.07 - .08
Chloride, tech., ton	12.00 -14.75	12.00 -14.75	12.00 -14.00
Cyanide, cases, dom., lb.	.16½- .17	.16½- .17	.18 - .20
Fluoride, bbl., lb.	.07½- .08	.07½- .08	.08 - .09
Hyposulphite, bbl., lb.	2.40 - 2.50	2.40 - 2.50	2.40 - 2.50
Nitrate, bags, cwt.	1.77 -	1.77 -	2.02 -
Nitrite, casks, lb.	.07½- .08	.07½- .08	.07½- .08
Phosphate, dibasic, bbl., lb.	.0265 - .03	.0265 - .03	.03½- .03¾
Prussiate, yel. drums, lb.	.11½- .12	.11½- .12	.11½- .12
Silicate (30° drums), cwt.	.60 - .70	.60 - .70	.60 - .70
Sulphide, fused, 60-62%, dr., lb.	.02½- .03½	.02½- .03	.03½- .04
Sulphite, cyrs., bbl., lb.	.03 - .03¼	.03 - .03¼	.02 - .03
Sulphur, crude at mine, bulk, ton	18.00 -	18.00 -	18.00 -
Chloride, dr., lb.	.05 - .06	.05 - .06	.05 - .06
Dioxide, cyl., lb.	.06½- .07	.06½- .07	.07 - .08
Flour, bag, cwt.	1.55 - 3.00	1.55 - 3.00	1.55 - 3.00
Tin bichloride, bbl., lb.	nom.-	nom.-	nom.-
Oxide, bbl., lb.	.26 -	.27½-	.34 -
Crystals, bbl., lb.	.24½-	.24 -	.25½-
Zinc chloride, gran., bbl., lb.	.06½- .06¾	.06½- .06¾	.06½- .06¾
Carbonate, bbl., lb.	.10½- .11	.10½- .11	.10 - .11
Cyanide, dr., lb.	.41 - .42	.41 - .42	.40 - .41
Dust, bbl., lb.	.05½- .06	.05½- .06	.07½- .08
Zinc oxide, lead free, bag, lb.	.06½-	.06½-	.06½-
5% lead sulphate, bags, lb.	.06½-	.06½-	.06½-
Sulphate, bbl., cwt.	3.00 - 3.25	3.00 - 3.25	3.00 - 3.25

Oils and Fats

	Current Price	Last Month	Last Year
Castor oil, No. 3, bbl., lb.	$0.10½-$0.11	$0.10½-$0.11	$0.11½-$0.12½
Chinawood oil, bbl., lb.	.08½-	.07½-	.07 -
Coconut oil, Ceylon, tanks, N. Y. lb.	.03½-	.03½-	.05½-
Corn oil crude, tanks, (f.o.b. mill), lb.	.04½-	.05½-	.07½-
Cottonseed oil, crude (f.o.b. mill), tanks, lb.	.03½-	.03½-	.06½-
Linseed oil, raw, car lots, bbl., lb.	.07½-	.07½-	.094-
Palm, Lagos, casks, lb.	.04½-	.04 -	.05½-
Niger, casks, lb.	.03½-	.03½-	.05½-
Palm Kernel, bbl., lb.	.05½-	.05 -	.06½-
Peanut oil, crude, tanks (mill), lb.	.05 -	.05 -	.07 -
Rapeseed oil, refined, bbl., gal.	.43 - .44	.42 - .43	.54 - .56
Soya bean, tank (f.o.b. Coast), lb	nom.-	nom.-	.08½-
Sulphur (olive foots), bbl., lb.	.04½-	.04½-	.06 -
Cod, Newfoundland, bbl., gal.	.26 - .28	.35 - .36	.53 - .55
Menhaden, light pressed, bbl., gal.	.33 - .34	.33 - .34	.45 - .47
Crude, tanks (f.o.b. factory), gal.	.20 -	.15½-	.20 -
Whale, crude, tanks, gal.	nom.-	nom.-	- .78
Grease, yellow, loose, lb.	.02½-	.02 -	.04½-
Oleo stearine, lb.	.06½-	.06½-	.08½-
Red oil, distilled, d.p. bbl., lb.	.07½-	.07½-	.08½-
Tallow, extra, loose, lb.	.03¼-	.02½-	.04½-

Coal-Tar Products

	Current Price	Last Month	Last Year
Alpha-naphthol, crude, bbl., lb.	$0.60 -$0.65	$0.60 -$0.65	$0.60 -$0.62
Refined, bbl., lb.	.80 - .85	.80 - .85	.80 - .85
Alpha-naphthylamine, bbl., lb.	.32 - .34	.32 - .34	.32 - .34
Aniline oil, drums, extra, lb.	.14½- .15	.14½- .15	.15 - .16
Aniline salts, bbl., lb.	.24 - .25	.24 - .25	.24 - .52

Coal-Tar Products (Continued)

	Current Price	Last Month	Last Year
Benzaldehyde, U.S.P., dr., lb.	$1.10 –$1.25	$1.10 –$1.25	$1.15 –$1.25
Benzidine base, bbl., lb.	.65 – .67	.65 – .67	.65 – .67
Benzoic acid, U.S.P., kgs, lb.	.48 – .52	.48 – .52	.57 – .60
Benzyl chloride, tech., dr., lb.	.30 – .35	.30 – .35	.30 – .35
Benzol, 90%, tanks, works, gal.	.20 – .21	.20 – .21	.21 – .22
Beta-naphthol, tech., drums, lb.	.22 – .24	.22 – .24	.22 – .24
Cresol, U. S. P., dr., lb.	.12½– .14	.12½– .14	.14 – .17
Cresylic acid, 97%, dr., wks., gal.	.54 – .58	.54 – .58	.60 – .70
Diethylaniline, dr., lb.	.55 – .58	.55 – .58	.55 – .58
Dinitrophenol, bbl., lb.	.29 – .30	.29 – .30	.30 – .31
Dinitrotoluen, bbl. lb.	.16 – .17	.16 – .17	.16 – .17
Dip oil 25% dr., gal.	.26 – .28	.26 – .28	.26 – .28
Diphenylamine, bbl., lb.	.38 – .40	.38 – .40	.39 – .40
H-acid, bbl., lb.	.65 – .70	.65 – .70	.68 – .70
Naphthalene, flake, bbl., lb.	.03½– .04¼	.03½– .04¼	.04½– .05
Nitrobenzene, dr., lb.	.08½– .09	.08½– .09	.08½– .10
Para-nitraniline, bbl., lb.	.51 – .55	.51 – .55	.51 – .55
Para-nitrotoluine, bbl., lb.	.29 – .30	.29 – .31	.29 – .31
Phenol, U.S.P., drums, lb.	.14¼– .15	.14¼– .15	.14¼– .15
Picric acid, bbl., lb.	.30 – .40	.30 – .40	.30 – .40
Pyridine, dr., lb.	1.50 – 1.75	1.50 – 1.80	1.50 – 1.80
R-salt, bbl., lb.	.40 – .44	.40 – .44	.44 – .45
Resorcinal, tech., kegs, lb.	.70 – .80	.70 – .80	1.15 – 1.25
Salicylic acid, tech., bbl., lb.	.33 – .35	.33 – .35	.33 – .35
Solvent naphtha, w.w., tanks, gal.	.26 –.....	.26 –.....	.28 – .30
Tolidine, bbl., lb.	.86 – .88	.86 – .88	.91 – .93
Toluene, tanks, works, gal.	.30 –.....	.30 –.....	.35 –.....
Xylene, com., tanks, gal.	.26 –.....	.26 –.....	.25 – .28

Miscellaneous

	Current Price	Last Month	Last Year
Barytes, grd., white, bbl., ton	$23.00–$25.00	$23.00–$25.00	$23.00–$25.00
Casein, tech., bbl., lb.	.07½– .14	.07 – .14	.10½– .12
China clay, dom., f.o.b. mine, ton	8.00 –20.00	8.00 –20.00	8.00 –20.00
Dry colors:			
Carbon gas, black (wks.), lb.	.03 – .20	.03 – .20	.05 – .22
Prussian blue, bbl., lb.	.35 – .36	.35 – .36	.35 – .36
Ultramine blue, bbl., lb.	.06 – .32	.06 – .32	.06 – .32
Chrome green, bbl., lb.	.27 – .28	.27 – .28	.27 – .30
Carmine red, tins, lb.	5.00 – 5.40	5.00 – 5.40	6.00 – 6.50
Para toner, lb.	.75 – .80	.75 – .80	.77 – .80
Vermilion, English, bbl., lb.	1.55 – 1.60	1.55 – 1.60	1.90 – 2.00
Chrome yellow, C. P., bbl., lb.	.16½– .17	.16½– .17	.17 – .17½
Feldspar, No. 1 (f.o.b. N.C.), ton	6.50 – 7.50	6.50 – 7.50	6.50 – 7.50
Graphite, Ceylon, lump, bbl., lb.	.07 – .08½	.07 – .08½	.04 – .05
Gum copal Congo, bags, lb.	.06 – .08	.06 – .08	.07½– .08
Manila, bags, lb.	.16 – .17	.16 – .17	.16 – .17
Damar, Batavia, cases, lb.	.16 – .16½	.16 – .19	.18 – .19
Kauri No. 1 cases, lb.	.45 – .48	.45 – .48	.48 – .53
Kieselguhr (f.o.b. N.Y.), ton	50.00 –55.00	50.00 –55.00	50.00 –55.00
Magnesite, calc, ton	40.00 –.....	40.00 –.....	40.00 –.....
Pumice stone, lump, bbl., lb.	.05 – .07	.05 – .08	.05 – .07
Imported, casks, lb.	.03 – .40	.03 – .40	.03 – .35
Rosin, H., bbl.	4.35 –.....	4.05 –.....	5.50 –.....
Turpentine, gal.	.41½–.....	.36 –.....	.41 –.....
Shellac, orange, fine, bags, lb.	.38 – .40	.38 – .40	.43 – .44
Bleached, bonedry, bags, lb.	.28 – .30	.28 – .30	.28 – .30
T. N. bags, lb.	.16 – .17	.16 – .17	.19 – .21
Soapstone (f.o.b. Vt.), bags, ton	10.00 –12.00	10.00 –12.00	10.00 –12.00
Talc, 200 mesh (f.o.b. Vt.), ton	8.00 – 8.50	8.00 – 8.50	9.50 –.....
300 mesh (f.o.b. Ga.), ton	7.50 –10.00	7.50 –10.00	7.50 –11.00
225 mesh (f.o.b. N. Y.), ton	13.75 –.....	13.75 –.....	13.75 –.....

	Current Price	Last Month	Last Year
Wax, Bayberry, bbl., lb.	$0.16 –$0.20	$0.19½–$0.22	$0.21 –$0.24
Beeswax, ref., light, lb.	.25 – .27	.25 – .27	.34 – .36
Candelilla, bags, lb.	.13½– .14	.13 – .14	.15½– .16
Carnuba, No. 1, bags, lb.	.32 – .33	.33 – .34	.27 – .28
Paraffine, crude 105-110 m.p., lb.	.03½– .03½	.03½– .04¼	.04¼– .05

Ferro-Alloys

	Current Price	Last Month	Last Year
Ferrotitanium, 15-18%, ton.	$200.00–.....	$200.00–.....	$200.00–.....
Ferromanganese, 78-82%, ton.	80.00–85.00	80.00–85.00	94.00–99.00
Ferrochrome, 65-70%.	.11–.....	.11–.....	.....–.....
Spiegeleisen, 19-21% ton.	30.00–.....	30.00–.....	33.00–.....
Ferrosilicon, 14-17%, ton.	31.00–.....	31.00–.....	39.00–.....
Ferrotungsten, 70-80%, lb.	1.00– 1.10	1.00– 1.10	1.10–.....
Ferrovanadium, 30-40%, lb.	3.15– 3.50	3.15– 3.50	3.15– 3.50

Non-Ferrous Metals

	Current Price	Last Month	Last Year
Copper, electrolytic, lb.	$0.07 –.....	$0.07 –.....	$0.10 –.....
Aluminum, 96-99%, lb.	.23 –.....	.23 –.....	.23 –.....
Antimony, Chin. and Jap., lb.	.06 –.....	.06 –.....	.07 –.....
Nickel, 99%, lb.	.35 –.....	.35 –.....	.35 –.....
Monel metal blocks, lb.	.28 –.....	.28 –.....	.28 –.....
Tin, 5-ton lots, Straits, lb.	.23 –.....	.22¼–.....	.25 –.....
Lead, New York, spot, lb.	.0405–.....	.04 –.....	.05 –.....
Zinc, New York, spot, lb.	.036–.....	.035–.....	.0465–.....
Silver, commercial, oz.	.35½–.....	.29½–.....	.35¼–.....
Cadmium, lb.	.55 –.....	.55 –.....	.70 –.....
Bismuth, ton lots, lb.	1.50 –.....	1.50 –.....	1.00 –.....
Cobalt, lb.	2.50 –.....	2.50 –.....	2.50 –.....
Magnesium, ingots, 99%, lb.	.30 –.....	.30 –.....	.65 – 1.00
Platinum, ref., oz.	40.00 –.....	40.00 –.....	36.00–.....
Palladium, ref., oz.	19.00 – 21.00	19.00 – 21.00	22.00– 23.00
Mercury, flask, 75 lb.	70.00 – 72.00	74.00 – 76.00	106.00–.....
Tungsten powder, lb.	1.45 –.....	1.45 –.....	1.70– 1.75

Ores and Semi-finished Products

	Current Price	Last Month	Last Year
Bauxite, crushed, wks., ton.	$6.50 –$8.25	$6.50 –$8.25	$7.50 –$8.00
Chrome ore, c. f., post, ton.	17.00 –20.00	17.00 –20.00	21.50 –25.00
Coke, fdry., f.o.b. ovens, ton.	2.75 – 2.85	2.75 – 3.85	2.75 – 2.85
Fluorspar, gravel, f.o.b. Ill., ton.	17.25 –20.00	17.25 –20.00	18.00 –20.00
Manganese ore, 50% Mn., c.i.f. Atlantic Ports, unit.	.25 – .26	.24 – .25	.31 – .36
Molybdenite, 85% MoS_2 per lb. MoS_2, N. Y., lb.	.45 –.....	.35 – .40	.48 – .50
Monazite, 6% of ThO_2, ton.	60.00 –.....	60.00 –.....	60.00–.....
Pyrites, Span. fines, c.i.f., unit.	.13 –.....	.13 –.....	.13 –.....
Rutile, 94-96% TiO_2, lb.	.10 – .11	.10 – .11	.10 – .11
Tungsten, scheelite, 60% WO_3 and over, unit.	10.50 –12.00	9.50 –12.00	12.25 –13.50

CURRENT INDUSTRIAL DEVELOPMENTS

New Construction and Machinery Requirements

Ammunition Factory—Western Cartridge Co. Ltd., C. A. Voight, V. Pres., Alberta, Calgary, acquired site and plans construction of a factory for manufacture of shot gun shells and small arms ammunition. Estimated cost $300,000.

Brass Foundry—Kinloch Brass Casting Co., 2356 Palm St., St. Louis, Mo., will soon award contract for a 1 story, 59 x 70 ft. foundry. Estimated cost $24,000. William P. McMahon, Buder Bldg., St. Louis, is architect.

Briquette Manufacturing Plant—Pittsburg & Ashland Coal & Dock Co., F. G. Hogan, Mgr., Ashland, Wis., preparing plans for the construction of a briquette manufacturing plant. Estimated cost $100,000. Roland C. Buck, Inc., 919 Tower Ave., Superior, are architects.

Chlorine—City of St. Paul, Minn., will receive bids until November 17 for furnishing 25 tons of liquid chlorine and 20 tons of pig lead.

Chemical Plant — Clorox Chemical Co., 850 42nd Ave., Oakland, Calif., will build addition to plant. $40,000. Work will be done by owner's forces. Steel contract awarded to California Steel Co., Second and Harrison Sts., Oakland.

Chemical Plants — Merrimac Chemical Co., Everett, Mass., awarded contract for a 1 story, 60 x 100 ft. central bottling plant to A. C. Peters, 46 Cornhill, Boston, also H-acid plant to Tredennick-Billings Co., 10 High St., Boston. Estimated cost $40,000 each.

Sodium Sulphate Plant — Whiteshore Lake Salts & Chemical Co., North Battleford, Sask., plans the construction of a dehydrating plant for development of sodium sulphate deposits in vicinity of Oban. Estimated cost to exceed $75,000. Canadian Salines Ltd., North Battleford, is lessee.

Cottonseed Products Plant—Marshall Cotton Oil Co., c/o W. C. Pierce, Marshall, Tex., awarded contract for a 2 story, 50 x 160 ft. cotton seed products plant, 70 ton daily capacity, to Frank Moos & Son, Marshall; machinery and equipment to E. B. Hayes Machinery Co., Marshall. Total cost $40,000.

Plant Addition—Carbon Dioxide & Chemical Co., c/o W. C. Cavenaugh, Mgr., Woodside, Utah, preparing plans for addition to dry ice plant. Estimated cost $100,000.

Plant—Owner, c/o W. C. Kirkpatrick, 124 West 4th St., Los Angeles, Calif., Engr., plans the construction of a dry ice plant at Hanford.

Enamel Factory—Moore Enameling Mfg. Co., West Lafayette, O., plans a 1 story factory adjoining present building, to be used for the manufacture of enameled kitchen utensils and will double capacity. Estimated cost $50,000. Private plans.

Enameling and Baking Plant—Canadian Westinghouse Co. Ltd., N. S. Braden, V. Pres., Hamilton, Ont., plans the construction of a new enameling and baking plant in connection with present plant. Estimated cost $250,000.

Gas Plant—Laclede Gas Light Co., 11th and Olive Sts., St. Louis, Mo., plans remodeling gas plant to include adjustment of equipment, distribution and service lines and customers appliances to permit mixing of natural gas with present manufactured gas. $500,000. Private plans.

Gas Plant — Northern New York Utilities Corp., 58 Park Sq., Watertown, N. Y., has been granted franchise for gas plant and main extensions at Howard.

Gas Plants—New York State Electric & Gas Corp., 22 Central Ave., Ithaca, N. Y., plans the construction of gas plants and main extensions at Freeville, Dansville and Van Etten.

Gas Plant Extensions—Elmira, Water Light and Railroad Co., Elmira, N. Y., plans extensions to gas plants and distribution systems at Erwin, Chemung, Veteran, Baldwin, Ashland, Elmira, Cayuta, Hector and Odessa.

Glass Products Plant — Vitric Products Co., 215 Commerce Exchange, Oklahoma City, Okla., is having plans prepared for a glass products plant at Oklahoma City. Estimated cost $200,000. F. W. Fenten, 215 Commerce Exchange, Oklahoma City, is engineer.

Gypsum Factory — Canada Gypsum Co., Hagersville, Ont., awarded contract for a 1 story factory building, also four new kilns at Guelph, to C. Crenna, 204 Elizabeth St., Guelph. Machinery and equipment will be installed.

Gypsum Factory—North American Gypsum Co., Baddeck, N. S., plans the construction of a gypsum factory. Estimated cost $150,000.

Chemistry Building Addition—California Institute of Technology, 1201 East California St., Pasadena, Calif., will receive bids until November 20 for a 3 story, 56 x 125 ft. addition to chemistry building. Estimated cost $300,000. Mayers, Murray & Phillips, 2 West 47th St., New York, N. Y., and Betram G. Goodhue Associates, are architects.

Laboratory — Babcock & Wilcox Co., East Third St., Bayonne, N. J., awarded contract for a 4 story laboratory building, to F. H. McGraw & Co., 51 East 42nd St., New York. Estimated cost $50,000.

Laboratory — Connecticut Agricultural Experimental Station, W. L. Slate, Huntington Road, New Haven, Conn., awarded contract for the construction of a laboratory building to Allyn Wadhams Co., 15 Lewis St., Hartford. $62,976.

Laboratory (Citrus-By-Products) — Department of Agriculture, Washington, D. C., is receiving bids for a citrus by-products laboratory at Texas Experiment station between Mercedes and Weslaco. Equipment will be required.

Laboratory (Oceanographic) — Board of Regents, University of Washington, Seattle, Wash., awarded contract for a 3 story, 60 x 135 ft. oceanographic laboratory to Fitton & Livergreen, Colman Bldg., Seattle, $138,400.

Laboratories—St. Peter's College, Jersey City, N. J., acquired site at Lincoln Park and plans the construction of a 10 story college building, including chemistry, biology and physics laboratories.

Laboratories—A. & M. College, College Station, Tex., will receive bids about Jan. 1 for a 3 story, 80 x 120 ft. agricultural engineering building and 3 story, 60 x 110 ft. petroleum engineering and geology building. Estimated cost $200,000 each. F. E. Giesecke, College Station, is architect. Work will be done by day labor. Equipment will be purchased later.

Pharmaceutical Plant—A. S. Boyle Co., Windsor, Ont., manufacturers of pharmaceutical supplies, cosmetics, etc., plans the construction of a plant at College and Campbell Sts. Estimated cost $50,000. Electrically operated machinery will be required. Walker Whiteside, Bank of Commerce Bldg., Windsor, in charge.

Malt Factory—Vancouver Malt & Sake Brewing Co., Ltd., 2235 Triumph St., Vancouver, B. C., awarded contract for a 50 x 93 ft. factory to include storage tanks, warehouse, fermenting room, bottling and shipping room, mash room and boiler rooms at 1145 Powell St., Vancouver.

Paper Mill — Marathon Paper Mills Co., Wausau, Wis., awarded contract for a paper mill to William Anderes, 412 First Ave., Wausau.

Paper Plant — Beach & Arthur, Inc., 221 West South St., Indianapolis, Ind., will build a 1 story, 40 x 104 ft. addition to factory for the manufacture of paper at 2900 Columbia Ave. Estimated cost $40,000. Private plans. Work will be done by owner's forces.

Paper Plant — Champion Fibre Co., R. B. Robertson, Pres., Canton, N. C., awarded contract for enlargement of paper plant, including construction of three large buildings to Morton C. Tuttle Co., 31 James St., Boston, Mass. Machinery and equipment to cost $500,000 will be required.

Pulp and Paper Mill — Thilmary Pulp & Paper Co., M. S. Wertheimer, Pres., Kaukauna, Wis., awarded contract for a 2 story, 60 x 95 ft. mill and turbine room to Permanent Construction Co., 208 South La Salle St., Chicago, Ill.

Plant—Mitsubishi Company of Tokyo, Japan, is preparing plans for a plant to manufacture patent fuel, 400,000 ton annual capacity. Estimated cost $300,000.

Plant Addition — United Shank & Findings Co., c/o United Shoe Machinery Corp., 140 Federal St., Boston, Mass., awarded contract for a 2 story addition to plant at Whitman to Casper-Ranger Construction Co., 6 Newton St., Holyoke. Estimated cost $40,000.

Refinery (Oil)—International Refineries, Inc., Oil City, Pa., preparing plans for refinery for production of lubricating oils. Estimated cost $100,000.

Refinery (Oil) — Peterson-Woodruff Oil Co., Harlingen, Tex., plans construction of an oil refinery to manufacture gasoline, kerosene, naphtha and tractor distillate. Estimated cost $30,000. Private plans. Work will be done by owner's forces.

Refinery (Oil) — Standard Oil Co. of Indiana, 137 West 11th St., Indianapolis, Ind., awarded contract for an oil refinery (cracking unit), 6,500 bbl. capacity at Casper, Wyo., to M. W. Kellogg Co., 225 Broadway, New York, N. Y.

Refinery (Oil)—Standard Oil Co., of Kansas, Neodesha, Kan., will build addition to oil refinery. Estimated cost $250,000. Work will be done by day labor and separate contracts.

Refinery (Oil)—Simrall Refining Corp., Union Central Bldg., Cincinnati, O., acquired a site on riverfront and plans construction of a refinery, for gasoline and fuel oils, 2,500 bbl. daily capacity at Amherstburg, Ont. Later it is planned to add plant for manufacturing kerosene and lubricating oils. George P. Eiehl is manager of Canadian plant.

Rubber Factory—Goodyear Tire & Rubber Co., 1144 East Market St., Akron, O., plans prepared for a 2 story factory, storage and distribution building at Cleveland. Estimated cost $100,000 including equipment.

Rubber Plant Equipment—Baldwin Rubber Co., Pontiac, Mich., leasing factory at West and Colborne Sts., Orillia, Ont., and will equip for the manufacture of products made from reclaimed rubber. $150,000.

Shell House and Magazine—Bureau of Yards & Docks, Navy Dept., Washington, D. C., will receive bids until November 18 for a 1 story, 50 x 200 ft. shell house and 1 story, 50 x 100 ft. magazine at Naval Ammunition Depot, Lake Denmark, N. J. Estimated cost $150,000. Private plans.

Soap Factory—Beach Soap Co., 125 Lawrence St., Lawrence, Mass., awarded contract for a 3 story, 30 x 30 ft. sulphur building to E. A. Peabody & Son, 310 Bay State Bldg., Lawrence. $25,000.

Soap Factory Addition—Lever Bros. Co., 164 Broadway, Boston, Mass., having plans prepared for a 4 story addition to soap factory at Hammond, Ind. Estimated cost $1,000,000. Stone & Webster Inc., 49 Federal St., Boston, Mass., are architects and engineers.

Soap and Tallow Factory—Los Angeles Soap Co., 617 East First St., Los Angeles, Calif., will soon award contract for the construction of first unit of soap and tallow factory, 1 story, 140 x 268 ft. Estimated cost $200,000. Morgan, Wells & Clements, 1135 Van Nuys Bldg., Los Angeles, are architects.

Steel Furnaces — American Manganese Steel Co., 33 North Michigan Ave., Chicago, Ill., awarded contract for rebuilding furnaces at Welland, Ont., to Volta Co., Burgar St., Welland, also plans installation of additional equipment.

Sulphate of Alumina—Passaic Valley Water Commission, 158 Ellison, Paterson, will receive bids until November 17 for furnishing and delivering lump sulphate of alumina during 1932 for Little Falls Pumping station, Little Falls.

Sulphur Extracting Plant — Texas Public Service Co., 40 Exchange Pl., New York, N. Y., plans the construction of a plant for extracting sulphur from natural gas at Texton, Tex. Estimated cost $110,000. Private plans.

Tallow Plant—I. Schonwalter, Meadow Lane, Elizabeth, N. J., awarded contract for a 1 and 2 story tallow factory on Woodruff Lane to Drill Contracting Co., 60 Park Pl., Newark. Estimated cost $40,000.

INDUSTRIAL NOTES

INTERNATIONAL-STACEY CORPORATION, Columbus, Ohio, has purchased the entire interest in the Stacey Manufacturing Co. and will conduct the divisions in Cincinnati as a unit of the parent company.

PERMUTIT COMPANY has appointed F. D. West as district sales manager with headquarters at 712 Brisbane Bldg., Buffalo, N. Y.

MUNDET CORK CORP. has moved its New York office to 450 Seventh Ave.

AMERICAN MANGANESE STEEL CO. has moved its Chicago office to 332 So. Michigan Ave.

LINK-BELT COMPANY, Chicago, announces the merger of George W. Moore Company, Chicago, with H. W. Caldwell & Son Co., its subsidiary, both to be operated as a division of the parent company.

SCEWENX SAFETY DEVICE CORPORATION has moved its facilities to 27 Water Street, New York.

SHEPARD NILES CRANE & HOIST CORP., has moved its Chicago office to 564 West Monroe St.

REPUBLIC STEEL CORPORATION has appointed G. E. Totten manager of sales of the tinplate Division with offices at Youngstown, Ohio.

FOOTE BROS. GEAR & MACHINE CO., Chicago, has appointed L. W. Erickson as district manager in Milwaukee.

GENERAL REFRACTORIES Co. has appointed H. S. Fleischer to its sales division with headquarters in New York.

HOMESTEAD VALVE MFG. Co. has appointed Chatard & Norris, 218 Water St., Baltimore, exclusive representatives.

HILO VARNIS CORPORATION has moved its factory and offices to 42 Stewart Avenue, Brooklyn, N. Y.

OWENS-ILLINOIS GLASS COMPANY, Toledo, Ohio, has appointed Harold Boeschenstein vice-president and assistant general manager, and F. J. Solon, general sales manager.

NORTH AMERICAN CEMENT CORPORATION has elected Thomas Harte as vice-president and sales manager to succeed F. A. Boeye, who died recently.

PLASTICS INDUSTRIES, INC., has moved its offices to its plant in Newark at Roanoke Avenue and Foundry Street.